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GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA

ANNUAL PROGRESS REPORT

PROJECT NO. 147

EFFICIENT PICKING, TRANSPORTING, HANDLING STORING, AND SHELLING OF FARMERS' STOCK PEANUTS

PREPARED FOR
STATE ENGINEERING EXPERIMENT STATION
AND
GEORGIA EXPERIMENT STATION

BY
T. A. ELLIOTT, B. W. CARMICHAEL, AND R. A. MARTIN

JULY 1, 1950-JUNE 30, 1955

CONTENTS

Librarian's note

The following publications grew out of research done on Project 147 but were not issued as reports of the project.

Sampling, grading and cleaning farmers' stock peanuts. By N. M. Penny, T. A. Elliott, J. J. Moder, Jr., and B. W. Carmichael. Atlanta and Experiment, Ga., June 1956. (Georgia Institute of Technology. Engineering Experiment Station. Bulletin no. 21)

Industrial engineering and economic studies of peanut marketing. By J. J. Moder, Jr. and N. M. Penny. Atlanta and Experiment, Ga., December 1954. (Georgia Institute of Technology. Engineering Experiment Station. Special Report no. 29)

Analytical study of the sampling and grading of farmers' stock peanuts. By J. J. Moder, Jr. Atlanta, February 25, 1952. (Georgia Institute of Technology. Engineering Experiment Station. Project 168. Special Report no. 1)

Please return to T. A. Elliott

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STATE ENGINEERING EXPERIMENT STATION

Cleaning Farmers' Stock Peanuts

T.A. Elliott, B.W. Carmichael
and
R.A. Martin

State Engineering Experiment Station
cooperating with
Georgia Experiment Station

Atlanta, Georgia

July 1, 1950

Georgia Institute of Technology
STATE ENGINEERING EXPERIMENT STATION
Atlanta, Georgia

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JULY 1, 1950

FOREWORD

This report contains a brief description of the experimental methods employed during fiscal 1949-50 for the purpose of evolving new methods and facilities for removing foreign material from farmers' stock peanuts. The research reported herein was supported by funds provided by the Georgia-Florida-Alabama Peanut Association, Camilla, Georgia, and by an equal amount of funds authorized under Title II of the Research and Marketing Act of 1946. The laboratory work was conducted by the State Engineering Experiment Station of the Georgia Institute of Technology, Atlanta, Georgia, in cooperation with the Georgia Experiment Station, Experiment, Georgia.

Work on this problem will continue during the next fiscal year. Also other problems related to picking, transportating, handling, storing, and shelling of peanuts will be studied for the purpose of improving the efficiency in these operations. Therefore, this report should be considered only as a statement of the progress of work accomplished in 1949-50.

Comments and suggestions from individual members of the peanut industry will be appreciated as this work continues.

W. T. Fullilove, Head
Department of Agricultural Economics
Georgia Experiment Station
Experiment, Georgia

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This Report Contains 64 Pages

I. SUMMARY

The investigation of three general methods of cleaning farmers' stock peanuts are included in this report: mechanical methods, electrostatic separation, and washing and drying of cured peanuts.

Cleaning by air blast, rotary disc screen, and V-corrugated slot screen comprise the mechanical methods studied. Principles of operation, laboratory scale tests, and the adaptation of these new principles to the cleaning problem are described. Results of laboratory tests indicate the possibility of efficient cleaning at capacities of 30 tons per hour on a six-foot-wide air-blast machine. The rotary disc screen and the V-corrugated slot screen will not clog in operation and are adaptable for use with existing machinery.

An investigation of the possibility of cleaning foreign material from farmers' stock peanuts by electrostatic means is described. Experimental work was directed towards determining the deflections of objects such as sticks, peanuts, and stones when dropped in an intense electric field. The equipment used and the data obtained are discussed, with particular attention to the utilization of the electrical field in a practical peanut cleaning machine. Results show that a definite separation can be effected by this method; however, practical application may require considerably more research effort.

A study of washing and drying was conducted in three phases:

1. A study was made of the relationship of rise in kernel temperature with respect to time for whole peanuts placed in a 150° C. forced-draft oven. Results obtained were plotted as temperature time curves.

2. The amount of moisture absorbed by shells and kernels during washing was investigated and the best procedures for drying were studied. Results showed shells absorbed high amounts of moisture and kernels relatively little moisture. Therefore, the drying problem is reduced to removal of moisture from the shells.

3. A study of the effect of washing and quick drying (approximately five minutes) on the germinative and edible properties of peanuts was made. It was found that germination was reduced five per cent at 150° C. and three per cent at 105° C., while the texture and taste of peanuts were not affected.

II. INTRODUCTION

A. General Information

The object of the initial phase of this project was the investigation of new methods of cleaning farmers' stock peanuts which would involve the design, development, construction, and evolution of units of pilot plant scale. To accumulate sufficient pertinent data and design information, preliminary work was performed on laboratory-scale models.

Hypothetical specifications were established for a cleaning machine which would: (1) handle 30 tons per hour of farmers' stock peanuts, (2) clean the peanuts better than existing machinery, (3) be low in first cost, operating cost, and maintenance, and (4) be simple and easy to operate and not require continuous adjustment or attendance.

The nomenclature used concerning peanuts conforms with the U. S. Grading Standards as specified by the 1949 program of the U. S. Department of Agriculture. The one variation from this is that the word "peanut(s)" is used to mean farmers' stock peanuts. A general unit of capacity was used (tons per hour per foot of width) so that the output of any method or machine could be compared on an equal basis.

All experimental work was done with Spanish-type peanuts, as it was evident that the physical characteristics were similar to the Runner-type peanuts insofar as mechanical processing was concerned.

B. Literature Search

A search of the literature revealed that little had been recorded regarding mechanical methods for cleaning peanuts. This condition indicated that much basic research in this field would be desirable, but because of the limited time and funds available numerous compromises had to be made in the selection of experiments for immediate study. Therefore, in many cases, arbitrary decisions, based on the general experiences of the workers, were made in regard to the selection of methods and design of equipment for these early experiments.

C. Field Trips

Field trips to various shelling plants in the Georgia, Florida, and Alabama area were made to gather general information and to observe the types of machines in use, the arrangement of the equipment, the flow of materials, the methods of handling the product, and the types of structures in use. Since all of the shelling plants could not be visited, a selection of what was believed to be a representative cross section of the various types and sizes throughout the area was made.

D. Testing

The present methods of cleaning peanuts, i.e., screening, air aspirators, and stoners, are limited in capacity to six to eight tons per hour and in most cases the cleaning is approximately 96 per cent efficient.

The possibilities for improvement involve the use of present principles with new design, the use of new principles and design, and combinations of the preceding. Three general concepts of cleaning were evolved which included: (1) mechanical methods; (2) electrostatic separation; and (3) washing and drying.

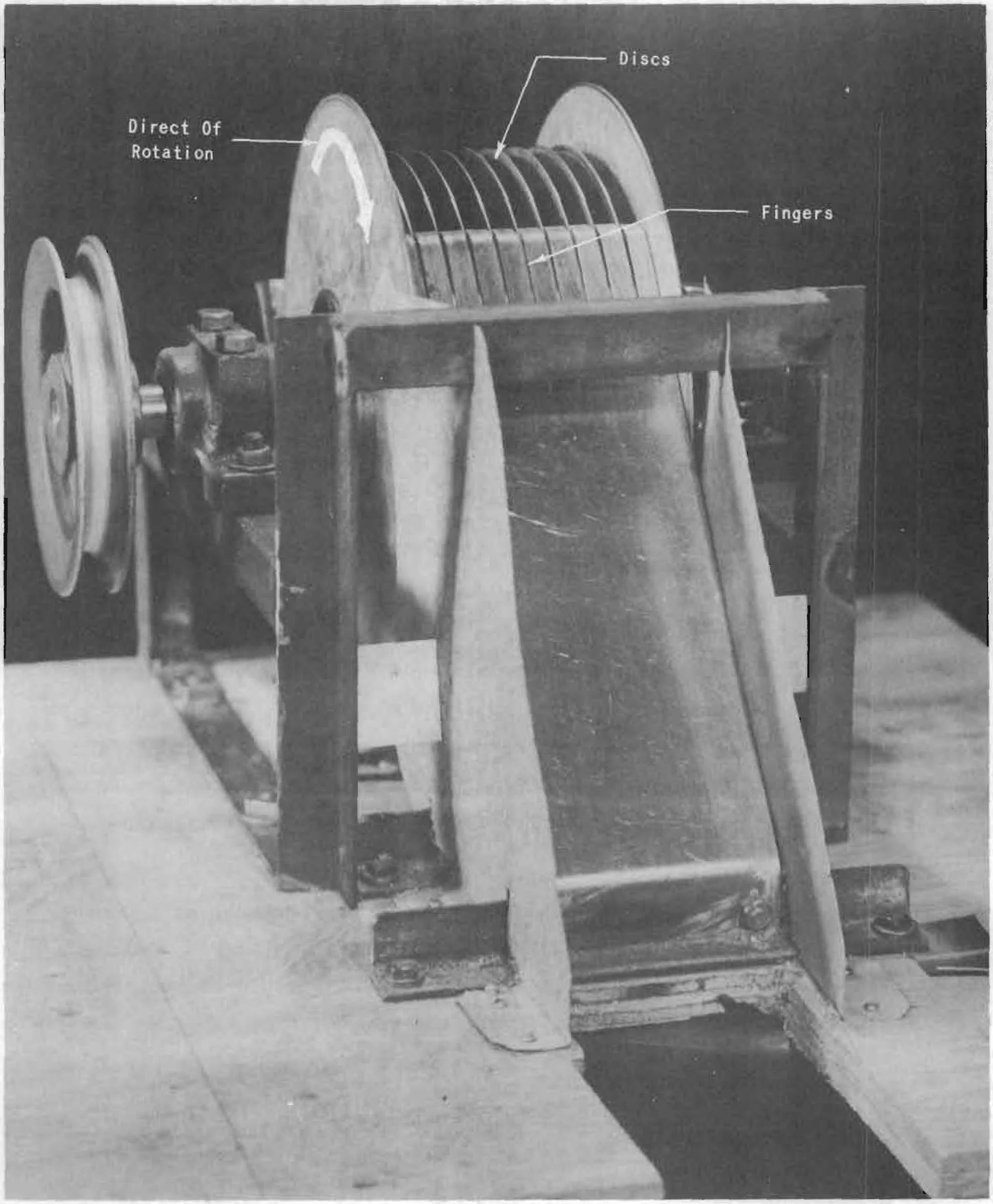
1. Mechanical Methods

a. Air Blast. This concept of cleaning involves the use of a horizontal stream of high velocity air (versus the existing use of a vertical air stream of relatively low velocity) through which the peanuts are dropped. A definite separation occurs which is dependent on the density and area of the particles introduced into the air stream. Four major separations take place in which rocks, peanuts, sticks, and light trash fall into four compartments. A substantiating discussion of this can be found in Appendix B together with a study of the effects of a vertical air stream on particles.

The use of a rotary feeder of high capacity was foreseen as a necessity for use with the air blast cleaner. If a vibrating screen would not handle the volume of material necessary other methods would be required. Capacity tests were made on this type of feeder.

b. Screening and Sizing

(1) Rotary Disc Screen. The results of tests of the air blast cleaner showed that some additional equipment was needed to supplement the cleaning operation. The need for a sizing or grading machine of high capacity was apparent (to separate the kernels and stones under 1/4 in. diameter from the peanuts). A rotary disc screen which is non-clogging, pictured in Figure 1, was built. Flat discs equally spaced on a rotating shaft satisfactorily perform the function of separating the ker-



Rotary Disc Screen For Separating Kernels

Figure 1.

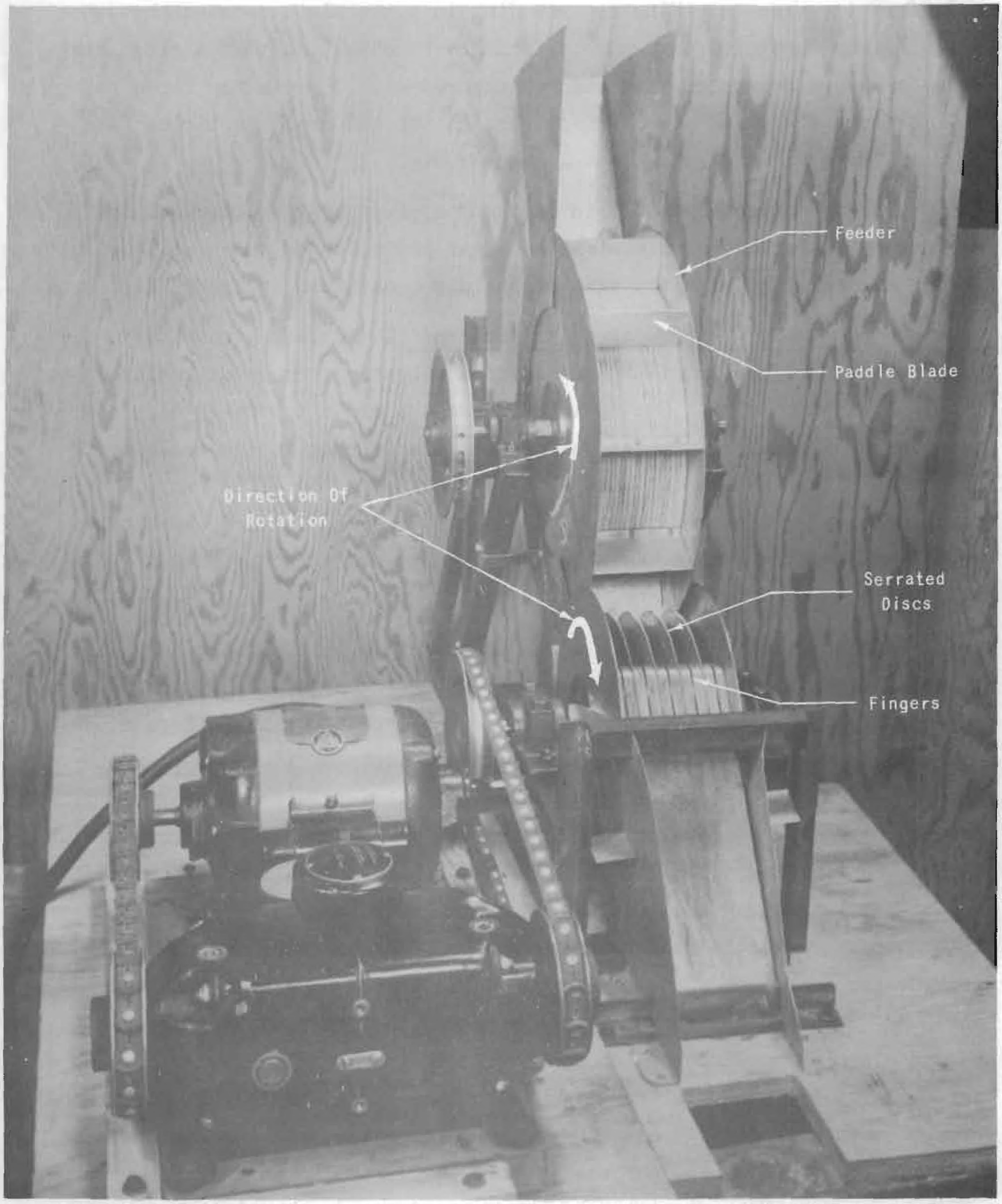
nels from the peanuts. Fingers extending into the slots between the discs dislodge any particles that have a tendency to stick, so that a clean surface is always presented to the incoming product. Objects too large to fall between the discs are carried over the top and small particles fall between the discs and report out a lower chute.

This screen can also be used as a means of separating sticks from peanuts by use of discs with serrated edges and a feeder which will orient the sticks parallel with the axis of the discs as shown in Figure 2.

(2) V-corrugated Slot Screen. The existing machinery used for screening consists basically of a vibrating screen with either round or slotted holes. One departure from this is a louvre-type screen used in some machines. The objection to a flat screen is the tendency to clog with either sticks or peanuts, thereby reducing the efficiency. Reciprocating brushes are used to overcome this. However, further cleaning is usually necessary in most cases by a roving attendant who by the use of a small rake cleans the screens.

A screen which would not clog would eliminate this problem and after trying various types of screens the idea of a V-corrugated slot screen was conceived. The screen consists of a corrugated bottom with guide strips on the apex of every other corrugation. Open slots of the desired width at right angles to the travel of the product allow the peanuts to fall through; the sticks travel on and report out at the end of the screen which can be seen in Figure 3. The limitation of this screen is that it removes only the sticks which are over twice the length of the screening slot. This characteristic is common to any screen. The original design was to provide the open slot so that a finger could travel back and forth and keep the slot clean. Subsequent tests proved that this was not necessary as no clogging has occurred on the screen in the experimental runs. The principle of operation is the alignment of the sticks axially in the direction of movement of the product by the V-corrugations and the guide strips. The latter serve a second purpose in that they extend over the slots; any stick which does not orient itself is conveyed across the slots by the guide strips.

(3) V-Bar Grizzly Screen. This screen, shown in Figure 4, was proposed as a device for separating sticks from peanuts. The principle of operation depended on the axial alignment of the sticks which would then



Rotary Disc Screen For Separating Sticks From Peanuts

Figure 2.

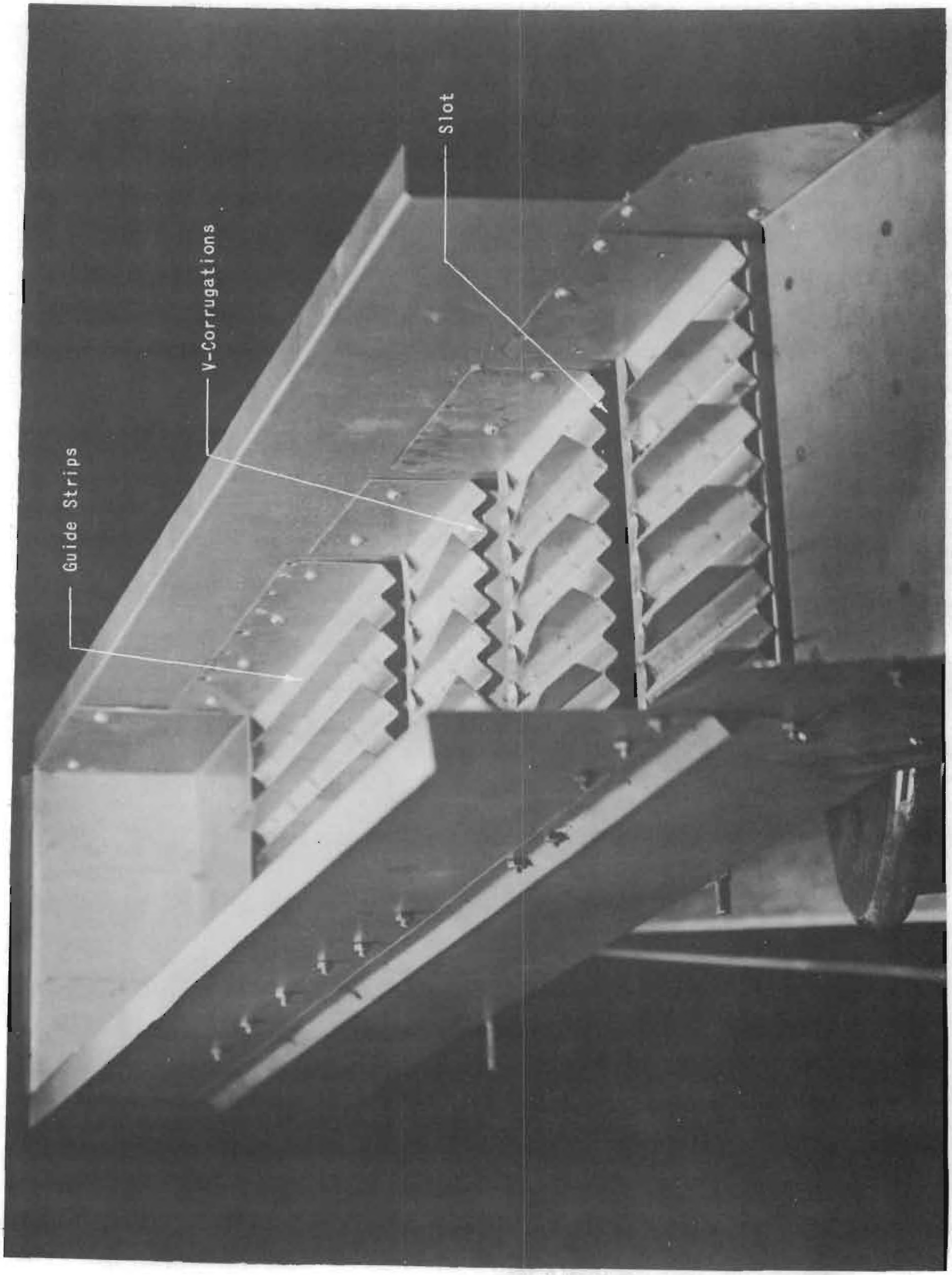


Figure 3. V-Corrugated Slot Screen For Separating Sticks From Peanuts

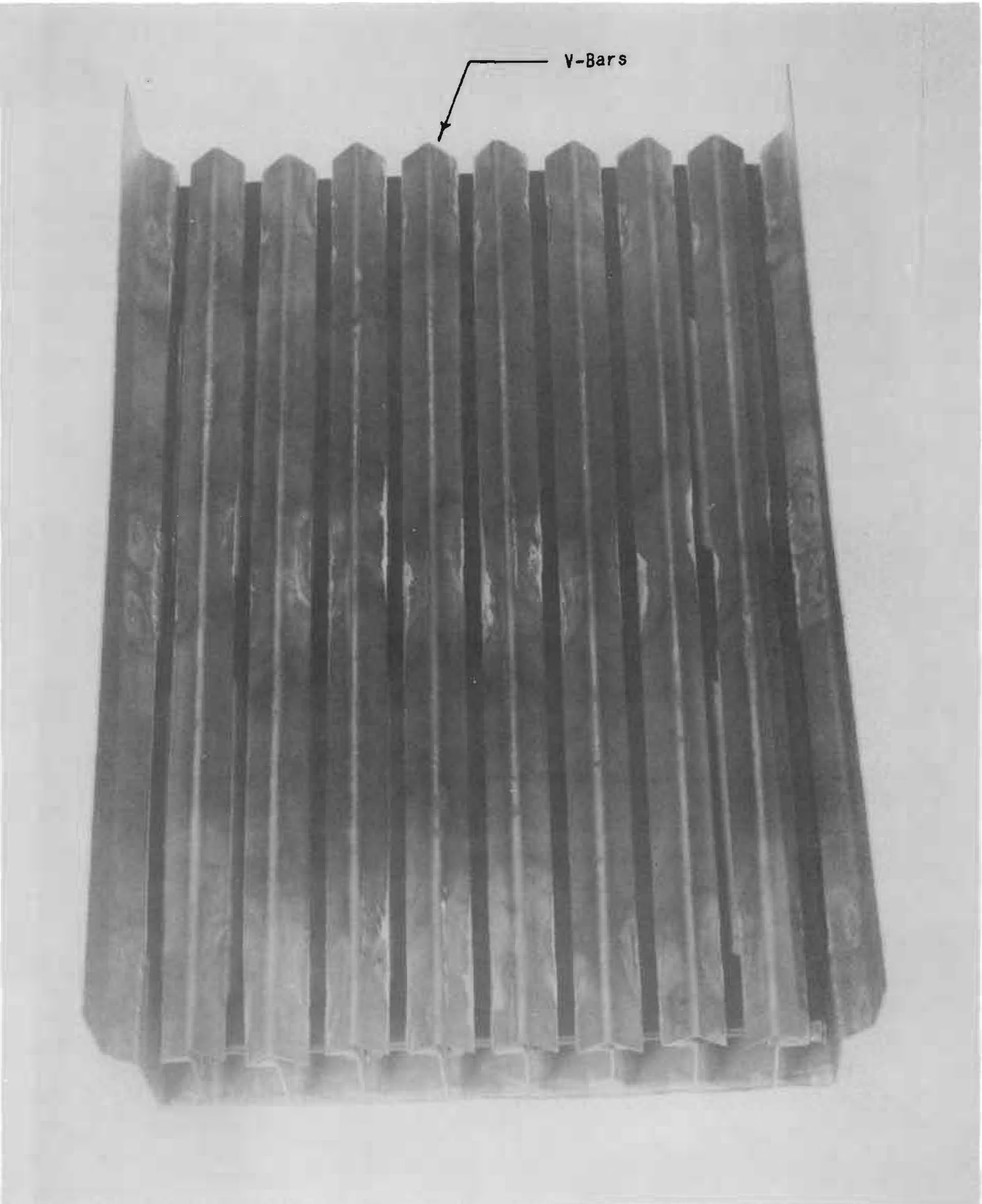


Figure 4. V-Bar Grizzly Screen For Separating Peanuts From Sticks

fall through the slots while the peanuts tailed over the end. The screen failed in operational tests on several counts: (1) the capacity was low as it was necessary to feed the product to the screen in a thin layer; and (2) clogging occurred in most cases in excessive amounts. A later modification which had the slots between the V-bars tapered eliminated the clogging; however, the low capacity remained and no further consideration was given this type of screen.

(4) Grate Louvre Screen. This screen, pictured in Figure 5, was built on the theory that regardless of their orientation the sticks would pass over the screen and the peanuts would fall through the louvres. Tests revealed excessive clogging due to sticks and peanuts hanging on the longitudinal grate bars, which precluded further investigation of this type screen.

c. Sloped Belt. The use of a sloped belt, shown in Figure 6, with a rough surface was tried as a means of separating sticks from peanuts. The idea was predicated on the principle that sticks, being irregular and nonsymetrical, would cling to the belt and be discharged at the top; the peanuts, being rounder and more symetrical, would roll down the belt. This method was tried; cork, rubber, and sand paper belts being used. Various combinations of angle of slope, belt speeds, volume of feed, and diverters were tried. The net results of this method were negative because the tails or stems of the peanuts would either prevent the peanut from rolling down the belt or would cling to the belt surface.

2. Electrostatic Separation

The early portion of this work was directed entirely to a search of the available literature on electrostatic separation methods and a study of the physical problem involved in the application of electrostatic forces to the cleaning of peanuts. The latter portion has been experimental with the purpose of determining if and how the electrostatic principle can be used in the design of a cleaning machine.

The literature search disclosed that application of this principle has been limited, in general, to the air purification, mining, and cereal industries. The mining industry used electrostatic machines for the separation of ore from undesirable material extensively during the early part of this century; however, flotation methods which operated more economi-

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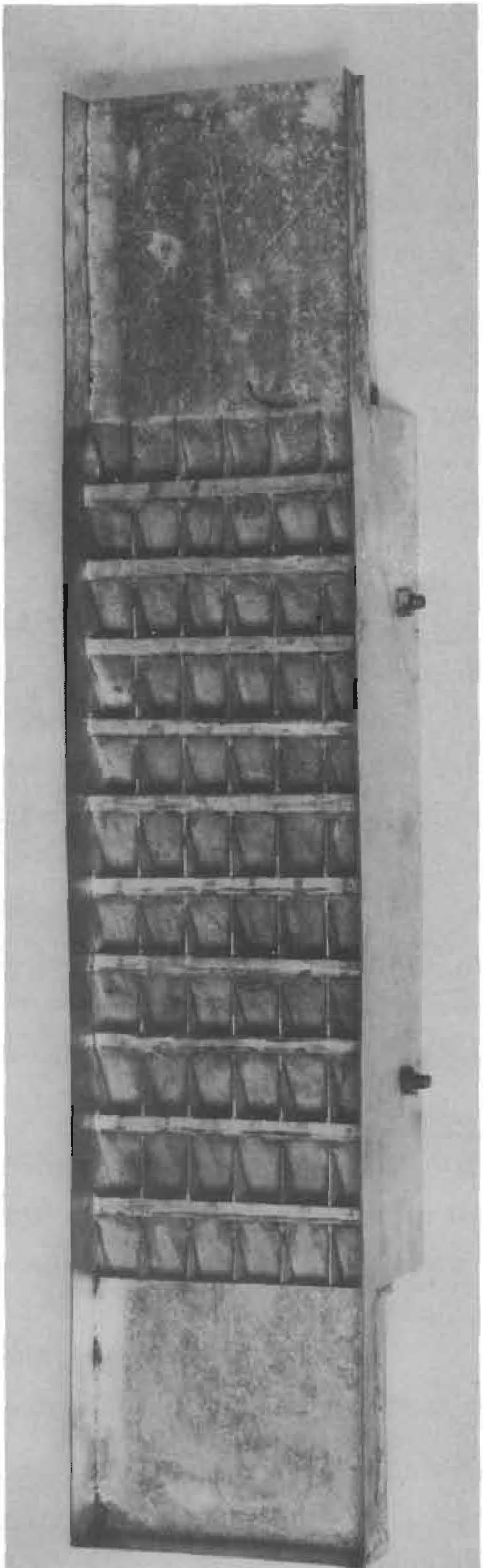
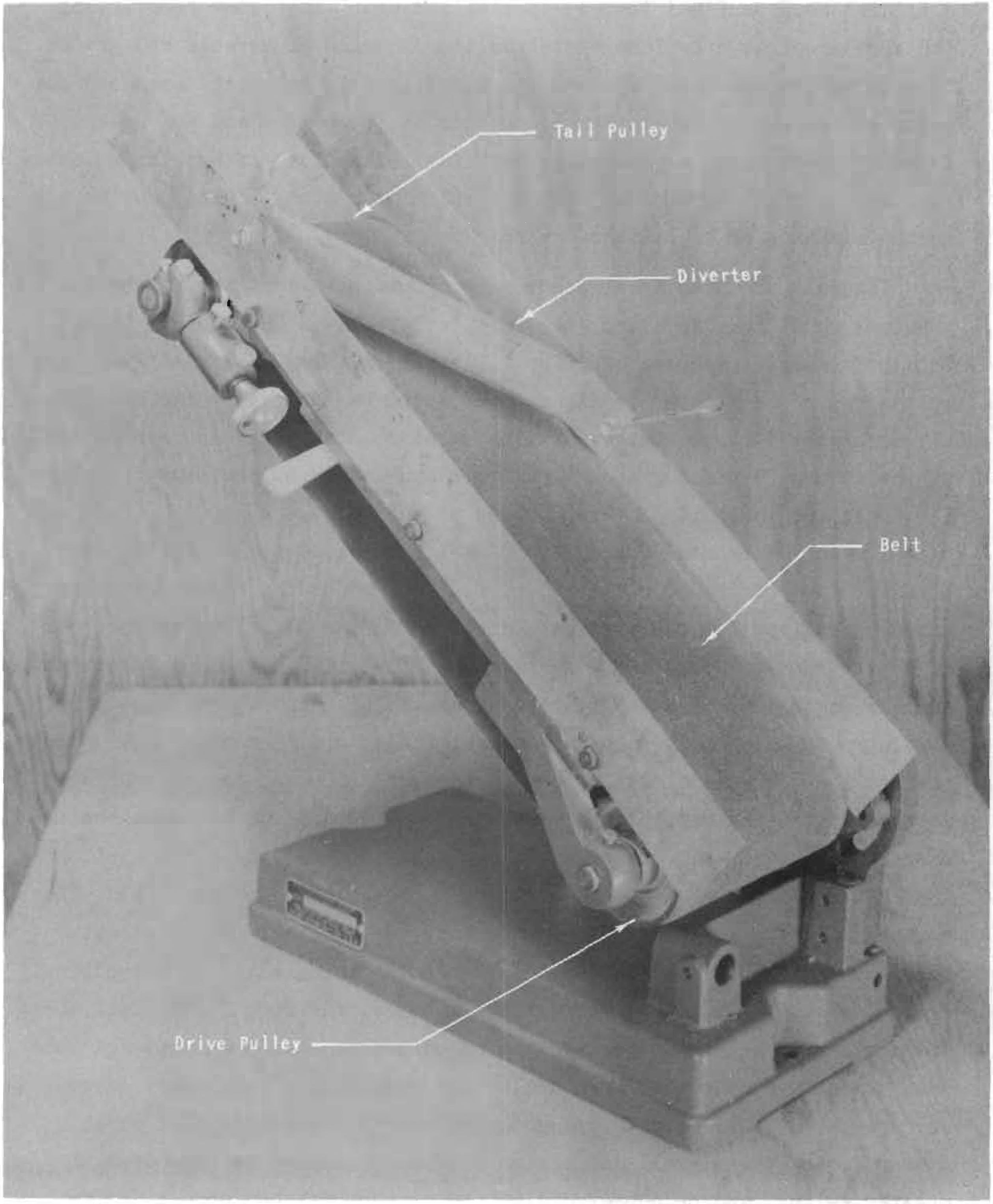


Figure 5. Grate Louver Screen For Stick Removal

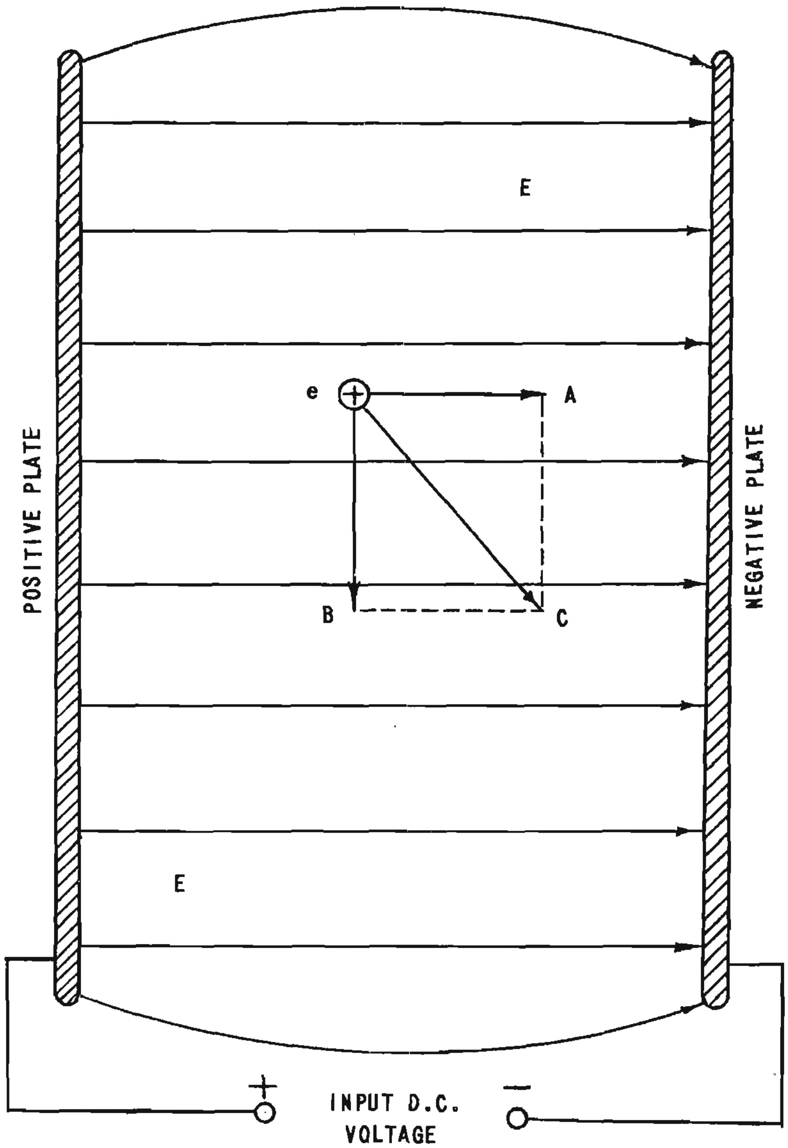


Sloped Belt For Separation Of Peanuts and Sticks

Figure 6.

cally replaced the electrostatic separators by 1926. Applications after that time were confined to very specialized uses, i.e., the recovery of the more precious ores from waste and the cleaning of cereals and grains. No application was found wherein the electrostatic principle was used for the cleaning and/or separation of objects of the nature and size found in farmers' stock peanuts prior to processing. This lack of background material was a definite handicap both in preliminary study of the problem and in the planning of experimental work.

Figure 7 shows an arrangement selected to point out the forces and physical conditions involved when an object falls in an electric field. This is a simple example, used for illustration only. For electrical and mechanical reasons other configurations would be more desirable and probably necessary for use in a separation machine. The field is represented by the arrows, beginning on the positive and ending on the negative plate. The field, of intensity E, is produced by the voltage applied between the plates. The horizontal force, A, on the object, due to the field, is equal to the product of e, the electrical charge on the object, and the field intensity, E. The vertical, downward force, B, is due to the pull of gravity and equal to the weight of the body. The motion of the object depends on the two forces acting at right angles. If objects are to be separated by falling through an electric field, a differential action must result; i.e., the resultant force, C, must be different for each object to cause differing deflections and hence separation. To increase the deflection the vertical force (weight) must be reduced and/or the horizontal force increased; i.e., the resultant must be directed to the right. The horizontal force is dependent on the charge e, constant field intensity being assumed. This charge depends in turn on the dielectric (electrical) properties of the material making up the object and upon its surface area. The desirable properties for separation of two objects then are: (1) object number 1, to have a large deflection requiring a relatively large surface area, small weight, and good dielectric properties; (2) object number 2, to have a small deflection requiring smaller surface area, greater weight, and/or poorer dielectric properties than object number 1. The preliminary study further revealed that the measurement of the surface area, charge, etc., of the various objects would require extremely sensitive and delicate instruments and even then would be questionable.



Force Diagram - Falling Body In An Electric Field

Figure 7.

For this reason calculation of the deflections was abandoned and the experimental apparatus, described later, set up to measure the deflections directly.

3. Washing and Drying of Cured Farmers' Stock Peanuts

It was desired to determine whether or not peanut kernels were affected adversely when cured farmers' stock peanuts were water-washed and the moisture content returned to its original value by a drying procedure taking on the order of approximately five minutes duration.

The advantages of water washing were felt to be:

1. Positive separation of rocks and dirt from peanuts.

2. Possible hardening or brittlizing of the shells during drying to facilitate shelling.

3. Possible moisturization of the kernels prior to shelling with resultant reduction in split content of the shelled goods.

III. EXPERIMENTAL WORK AND DISCUSSION

A. Mechanical Methods

1. Air Blast Cleaner

The equipment set up consisted of a feed hopper, a Syntron vibratory feeder (model F-0), a chute, a blower and nozzle, and a bin with dividers, as shown in Figure 8. A background with four-inch squares was erected for photographic purposes. Preliminary test drops of individual particles were made using three- and ten-inch-deep nozzles. The particles were dropped from various heights; curves, given in Figures 9 and 10, were plotted showing the distribution of rocks, peanuts, and heavy sticks. The optimum height of drop for each nozzle could be determined from these curves. It was found that for any specific air velocity there is a definite height of drop which gives the best separation of the particles. Higher velocities increased the spread of all the material. Consideration of the design of a working model and a study of the existing data revealed that a 10- to 15-inch drop with an air stream velocity of 5,600 to 6,000 feet per minute (approximately 60 miles per hour) and a nozzle three to five inches deep would give the most favorable results with a minimum of space requirement. The specific arrangement used for tests referred to in this report was a three-inch-deep nozzle, 5,600 feet per minute air speed with a ten-inch drop.

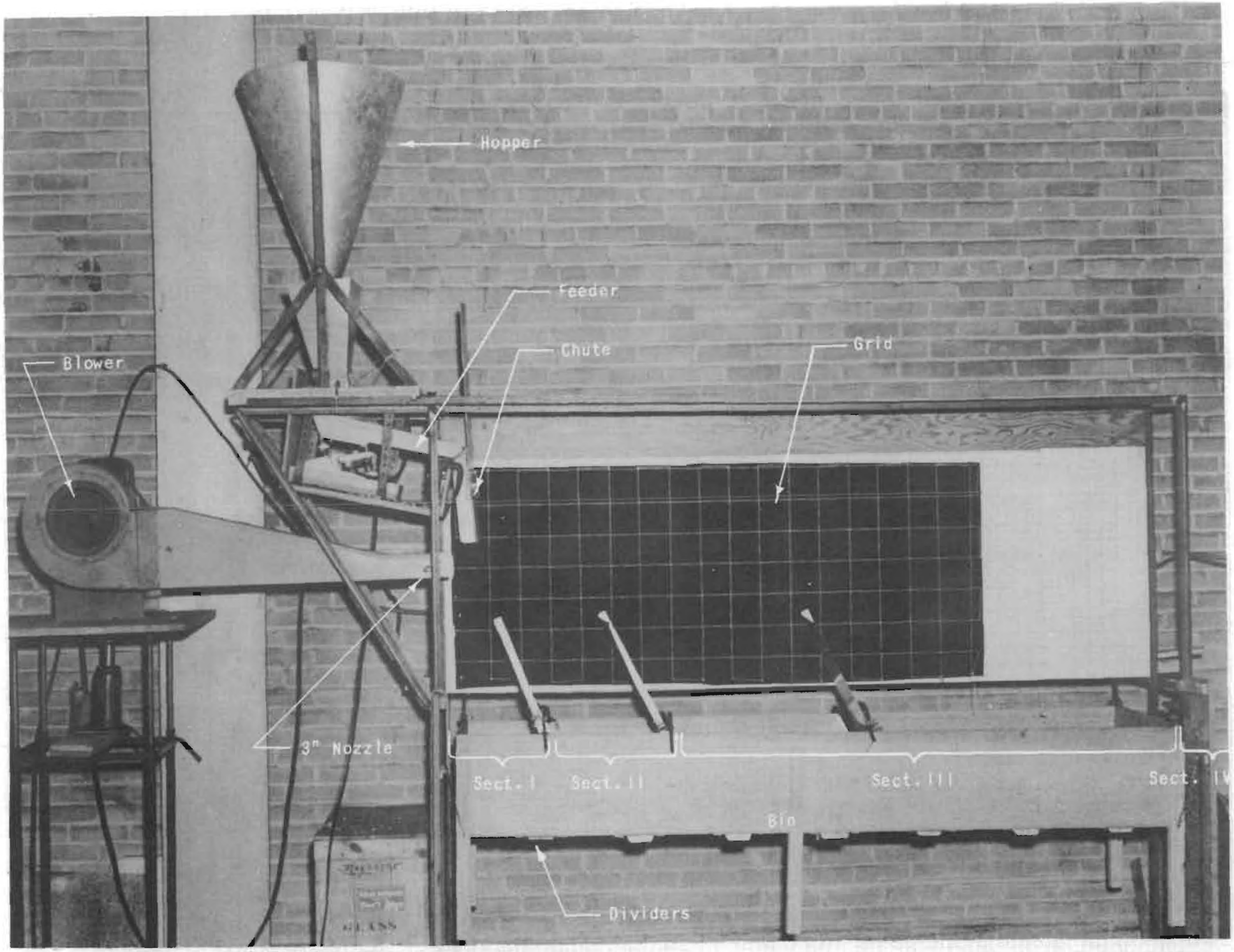
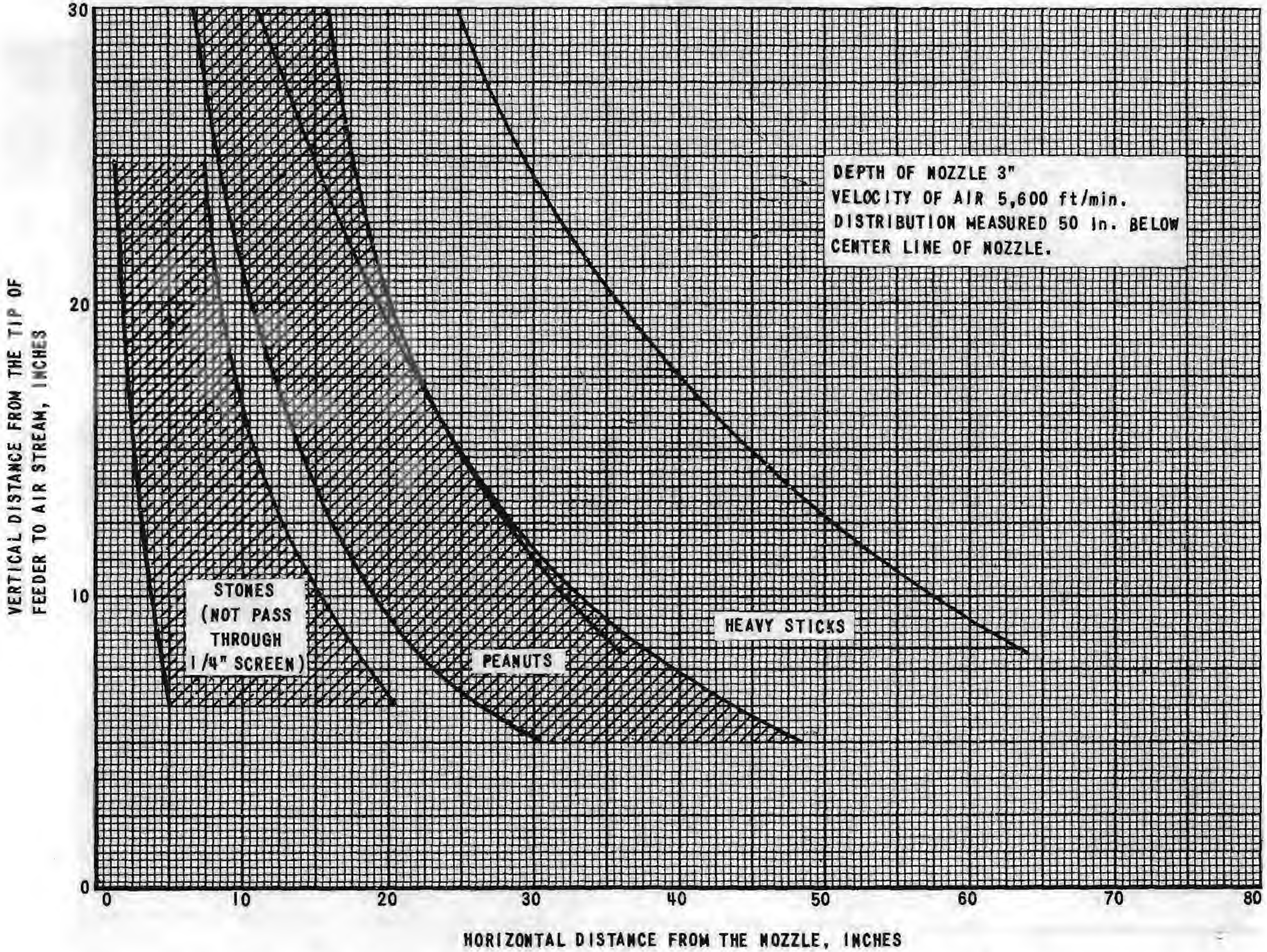


Figure 8. Air Blast Cleaner



Effect Of Feeder Height On Distribution Of Peanuts, Stones and Heavy Sticks
Figure 9.

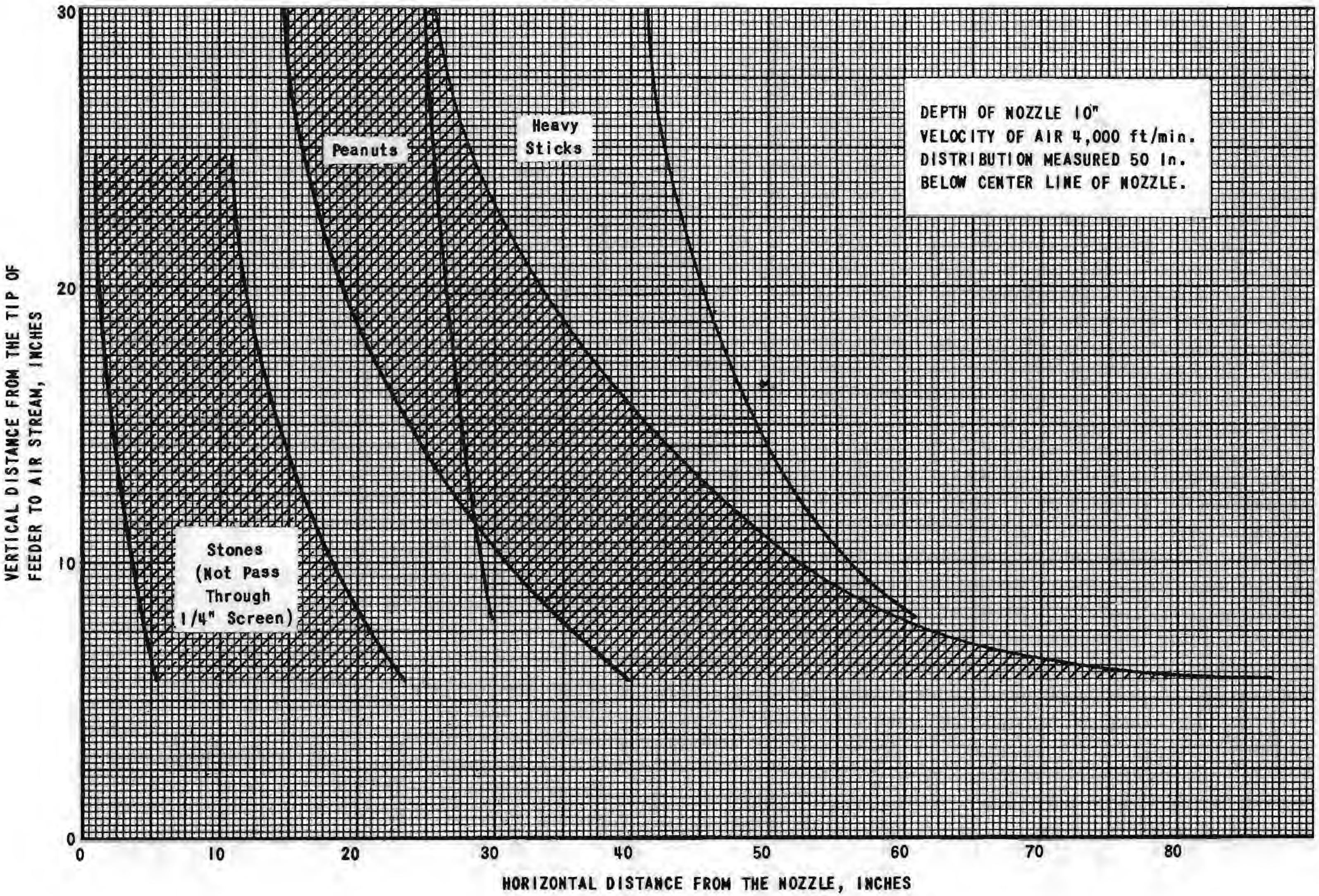


Figure 10. Effect of Feeder Height On Distribution of Peanuts, Stones and Heavy Sticks.

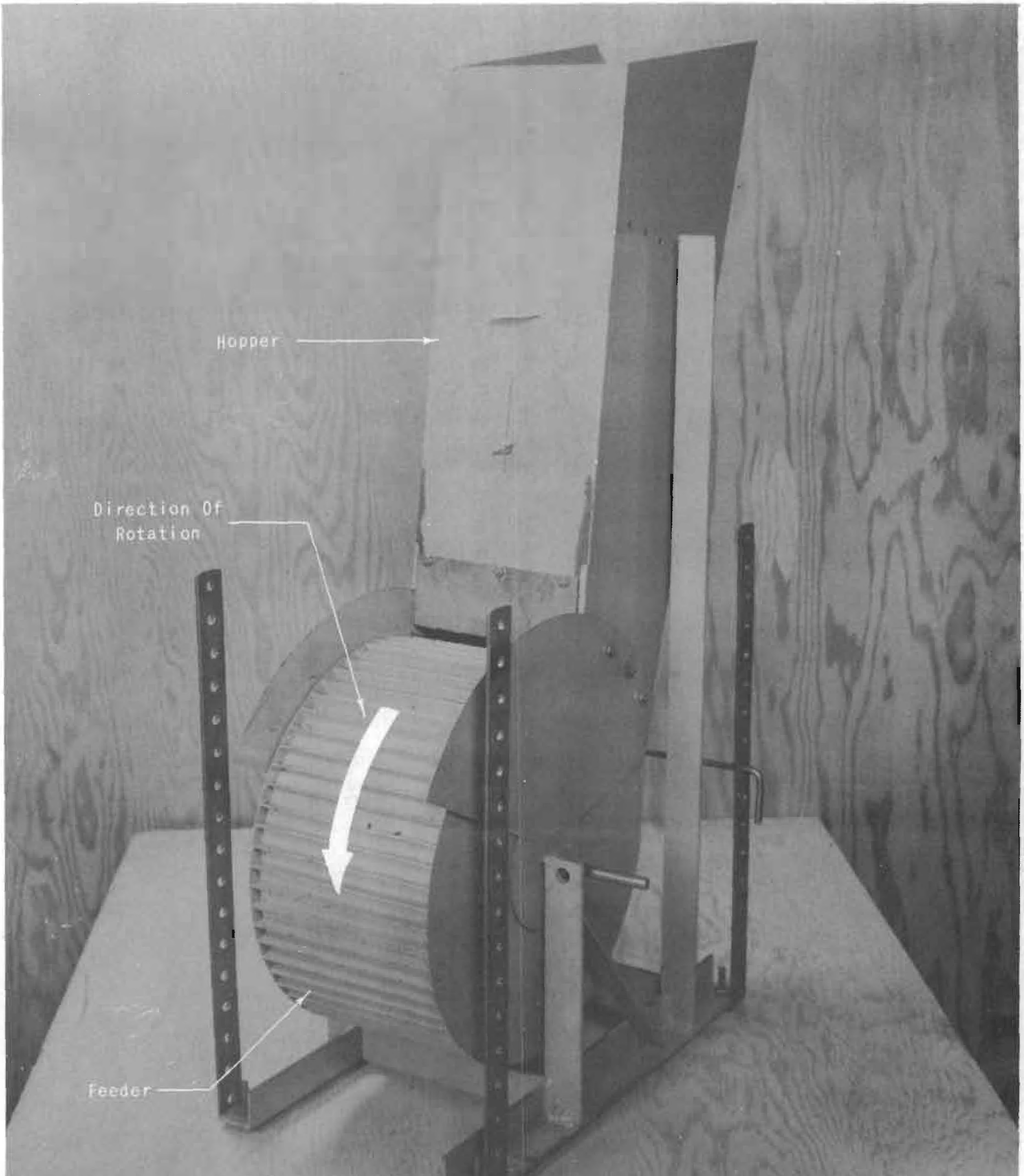
The chute between the feeder and the air stream was found necessary as it performs the function of aligning the axis of the sticks in a plane which is 90 degrees to the direction of flow of the air stream; i.e., the sticks are introduced to the air stream so that the maximum area is exposed to the force of the air, thereby insuring optimum separation of the sticks from the peanuts.

Test runs were made on 40 lb. batches and the data recorded. High speed pictures at 750 frames per second were taken with an Eastman Fastex camera for study of the separation, possible interference between particles, and general information of the action. (Prints from the film could not be made, but the 16 mm film is available for showing.)

The rotary feeder shown in Figure 11 was constructed. Various combinations of angle of hopper and speed of rotation were tried. The best results obtained were five tons per hour per foot of width with hopper at an angle of 20 degrees from the verticle and the feeder turning at 100 rpm.

The basic components of the Air Blast Cleaner are extremely simple, consisting of elementary machinery. A blower and a high capacity feeder comprise the machine. The separation that occurs is extremely rapid and the cleaner is capable of handling five tons per hour per foot of width. For a six-foot-wide machine this would give a capacity of 30 tons per hour of farmers' stock peanuts. The distribution of the product, given in Table I, is stated in total weights. For any batch of peanuts there will be a percentage of rocks, peanuts, sticks, trash, and hulls. The per cent of available material and distribution obtained by use of the air blast cleaner are shown in Table II. It can be seen that the air blast cleaner does not do a perfect cleaning job but it does at high capacity segregate the product into sections which allow separation on small volumes of material containing the majority of the foreign material while 90 per cent of the available peanuts are cleaned (99.6 per cent free from foreign material) and ready for the next process.

A block diagram, Figure 12, shows the necessary components which would be incorporated to make an air blast cleaner and the flow of material through the process. This diagram is one of the many possibilities that could be adapted from combinations of equipment and portrays an arrange-



Rotary Feeder

Figure 11.

TABLE I

DISTRIBUTION BY WEIGHT

RATE OF FEED:	5 tons/hr./ft. width	TIME REQUIRED:	59.4 seconds
MATERIAL:	40 lbs. farmers' stock peanuts	NOZZLE:	3 inches deep x 7 inches wide
WIDTH OF FEED:	3 inches	AIR VELOCITY:	5,600 fpm

SECTION	I		II		III		IV		
Material	Wt. lbs.	o/o Total	Wt. lbs.	o/o Total	Wt. lbs.	o/o Total	Wt. lbs.	o/o Total	Total Weight
Rocks	0.66	1.65	0.06	0.15	0.00	0.00	0.00	0.00	0.72
Sticks & Trash	0.00	0.00	0.13	0.325	0.66	1.65	1.78	4.45	2.57
Kernels	0.06	0.15	1.73	4.325	0.60	1.50	0.00	0.00	2.39
Peanuts	0.60	1.50	30.92	77.30	2.80	7.00	0.00	0.00	34.32
Total Peanuts and Kernels	0.66	1.65	32.65	81.625	3.40	8.50	0.00	0.00	36.71
TOTAL	1.32	3.30	32.84	82.10	4.06	10.15	1.78	4.45	40.00

ment which would give a clean product at high capacity. The numerical figures in the block diagram represent the tonnage distribution if handled on a 30 ton per hour capacity, based on laboratory results obtained on the test equipment.

TABLE II

DISTRIBUTION BY PER CENT OF AVAILABLE MATERIAL IN BATCH

RATE OF FEED:	5 tons/hr./ft. width	TIME REQUIRED:	59.4 seconds
NOZZLE:	3 inches deep x 7 inches wide	WIDTH OF FEED:	3 inches
MATERIAL:	40 lbs. farmers' stock peanuts	AIR VELOCITY:	5,600 fpm

SECTION	I	II	III	IV	Total
Rocks	91.67	8.33	0.00	0.00	100
Sticks & Trash	0.00	5.06	25.68	69.26	100
Kernels	2.51	72.39	25.11	0.00	100
Peanuts	1.75	90.09	8.16	0.00	100
Total Peanuts and Kernels	1.80	88.94	9.26	0.00	100

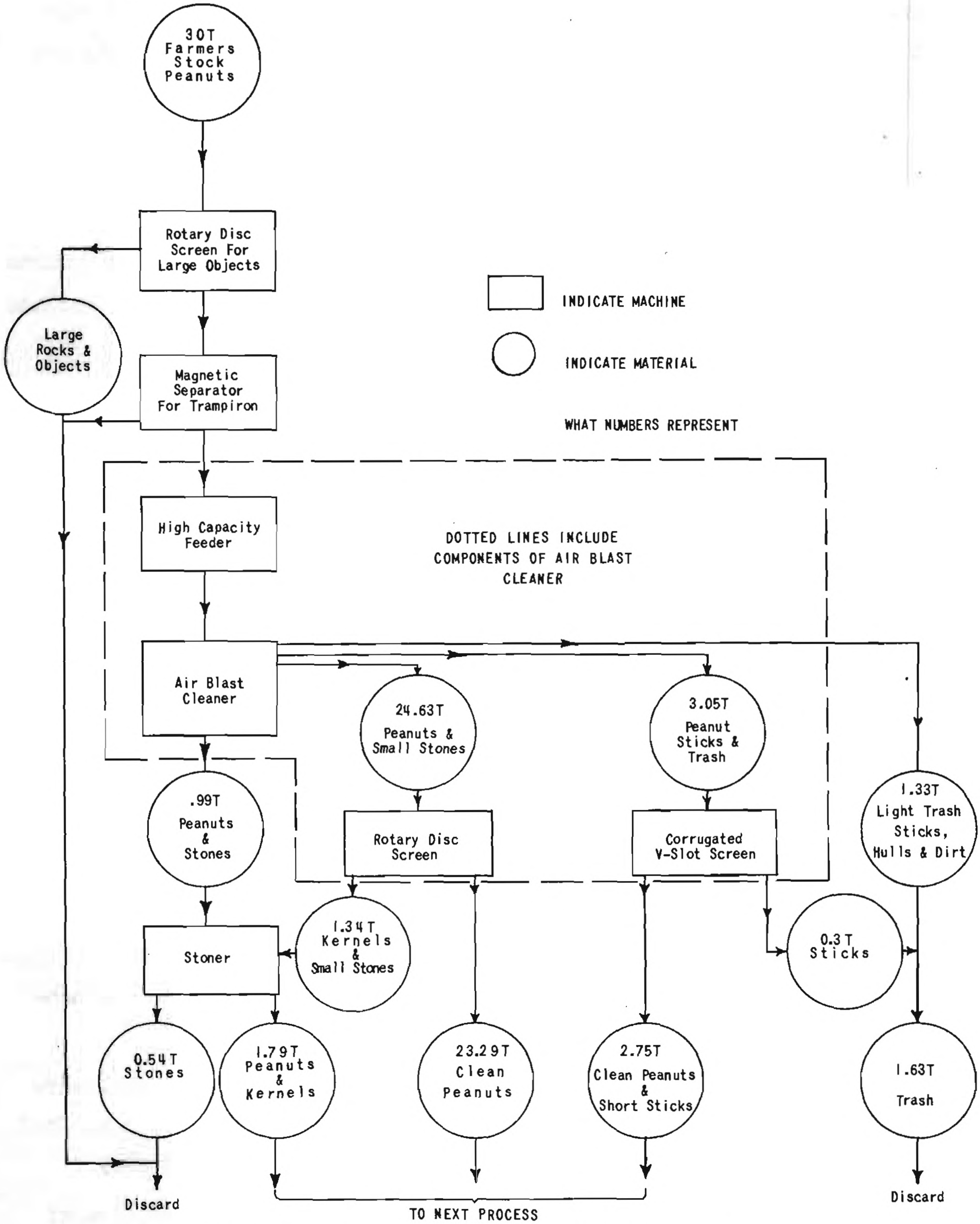
2. Screening and Sizing

a. Rotary Disc Screen

(1) Sizing. The rotary disc screen was set up (Figure 1) with the discs spaced 3/8 inch apart. The discs were eight inches in diameter. Over-all width of the machine was four inches, and a three-inch-wide feed chute was used.

The material was fed onto the rotating discs and various tests were conducted to determine the speed of rotation and the maximum rate of feed that could be accomodated to give the optimum separating efficiency.

The screening characteristics were excellent and the separation of the kernels and small stones (1/4 inch diameter and smaller) from the peanuts was 99.7 per cent. The material was handled at the rate of two tons per hour per foot of width when the discs rotated at a speed of 100 rpm.



Schematic Block Diagram Of Air Blast Cleaner and Associated Equipment

Figure 12.

(2) Separating Sticks. The rotary disc screen (Figure 2) was set up having discs with serrated edges spaced 1-1/8 inches apart. While the feeder mounted above the screen rotated, the peanuts were introduced into the top of the feeder. The paddle blades oriented the sticks parallel to the axis of the discs and the sticks were carried over the top of the discs while the peanuts fell into the spaces between. The rate of feed was one ton per hour per foot of width at a speed of 60 rpm of the discs. The separation of sticks over 2-1/4 inches in length was 99.6 per cent, and 30 per cent of the sticks 1-1/4 to 2-1/4 inches were removed.

(3) Discussion. These methods of screening provide non-clogging means of separating particles for size. Their use as a separator for sticks is good but the capacity is limited. An added increase in capacity for sizing can be realized by the use of larger diameter discs than were used in the laboratory tests. Also, as the distance between the discs is increased (i.e., for separating large objects from peanuts) the capacity increases to five tons per hour per foot of width.

b. V-Corrugated Slot Screen. This screen was fabricated from 24 gauge sheet metal spot-welded together. Figure 3 shows the final model of several models made. In this case the width was ten inches with 3/4-inch slots. Vibration was accomplished in the standard manner (screen set on supports inclined at approximately 15 degrees from the vertical) with an adjustable eccentric driven by a variable speed drive. Best results were obtained with a throw of the eccentric of 1/32 inch at 1,400 rpm. The slow feed at this amplitude of vibration was overcome by the base of the mechanism being inclined at a six degree angle.

The results from tests showed a capacity of one ton per hour per foot of width with 98 per cent of the sticks over two inches of length and 90 per cent of the sticks under two inches in length being removed. No clogging of the screen occurred at any time during the tests.

Although the capacity of this type screen roughly is the same as that of existing screens it offers several advantages. One is the nonclogging feature of the screen, another is the adaptability (the screen can be adjusted in place for width of slot), and a saving in over-all length can be effected.

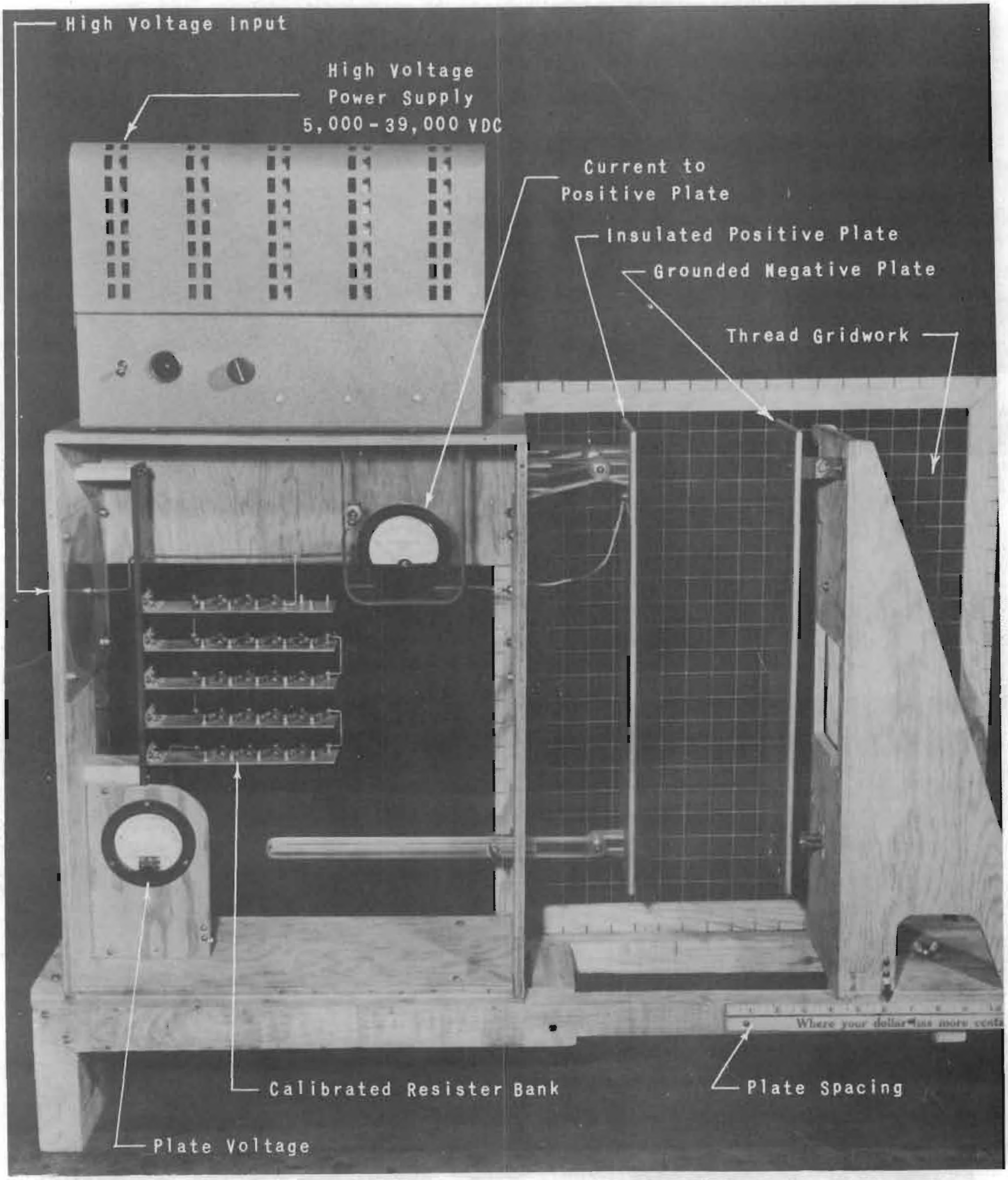
B. Electrostatic Separator

Experimental work to date has included the design, construction, and operation for a short period of time of a system for obtaining the horizontal deflection of objects dropped into an electric field. The plate arrangement of Figure 13 was used in combination with a stroboscopic photography system to provide a series of "fast-action" photographs of the moving object on a single piece of film. With a grid, photographed in the background, the film provided a plot of the objects' path in the field.

Figure 13 shows the electrical equipment that was used. The insulated positive and the grounded negative plate are shown on the right. Both plates are mounted on hinged supports so that either the parallel or the slanted position may be selected. The power supply (radio frequency oscillator-rectifier type) resting on top of the wood frame furnishes direct current voltage that is variable from approximately 5,000 to 39,000 volts to the plates. The meter at the lower left, in conjunction with the calibrated resistor bank above it, measures this voltage; the other meter indicates the current flowing to the positive plate. This current is normally extremely small (five to ten microamperes) and consists of the leakage current across the insulators and the current flow to ground (corona discharge) due to ionization of the air in the region of the positive plate. The network back of the plates is made of white thread to form one inch squares. When photographed against a "dead" black backboard, the crossed threads appear as the background grid for measurement of object deflection.

The photographic recording equipment is shown in Figure 14. The power supply and lamp control unit, on the right, furnish voltage of the proper magnitude and time duration for flashing of the lamps, on the left. The lamps provide intense flashes of light with a flash duration of approximately ten microseconds. The camera shown is a commercial type and is mounted to "shoot" through the opening between the lamps. The synchronizing unit and the object dropping mechanism (solenoid-operated, quick-opening pincers) are shown on top of the lamp power supply.

The electrostatic and photographic equipment, assembled approximately as when in use, are shown in Figure 15. Figure 16 is a functional diagram of the complete arrangement and illustrates its over-all operation. Prior to the exposure of the film, voltage is applied to the lamp power



Experimental Electrostatic Separation Equipment
Figure 13.

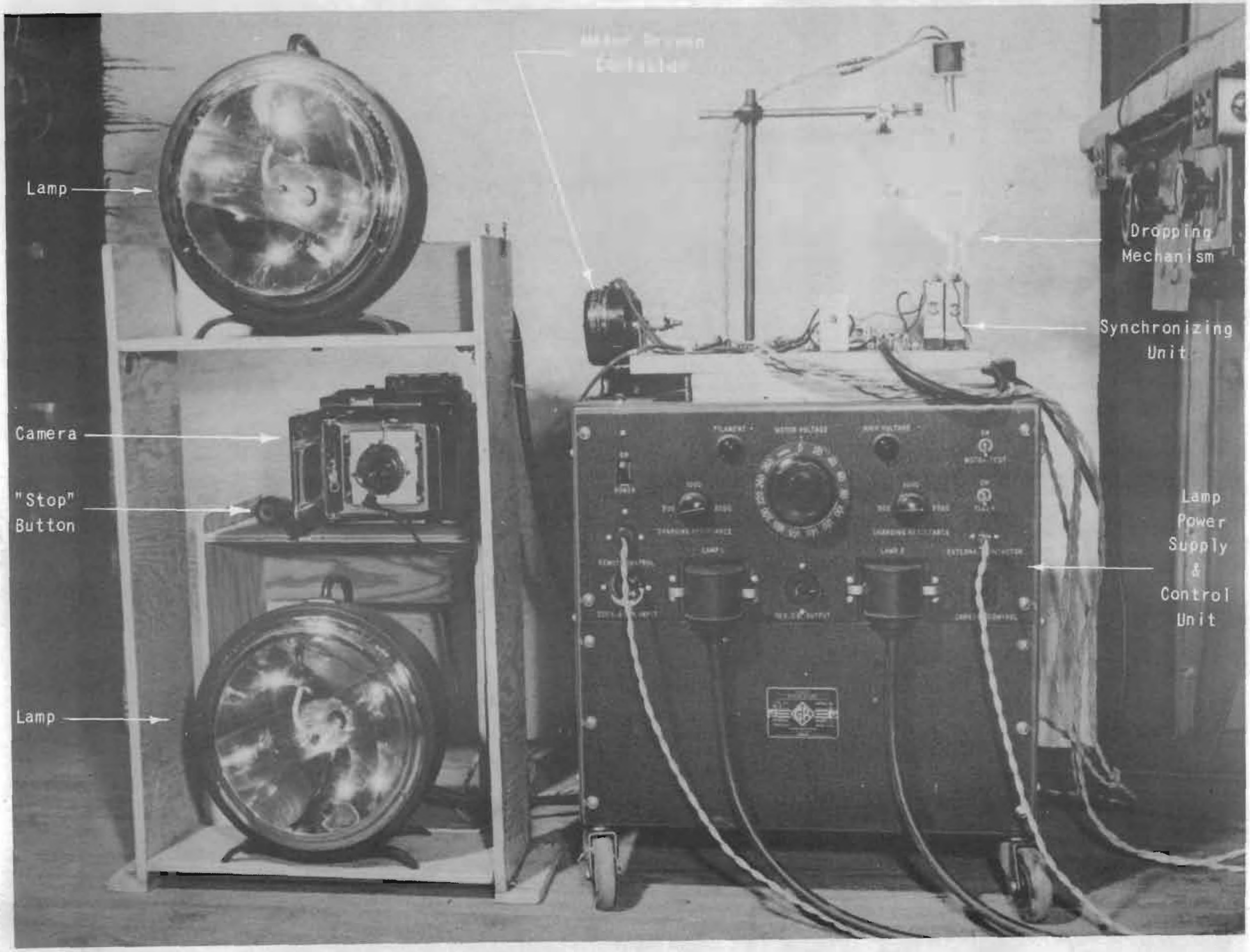


Figure 14. Photographic Recording Equipment

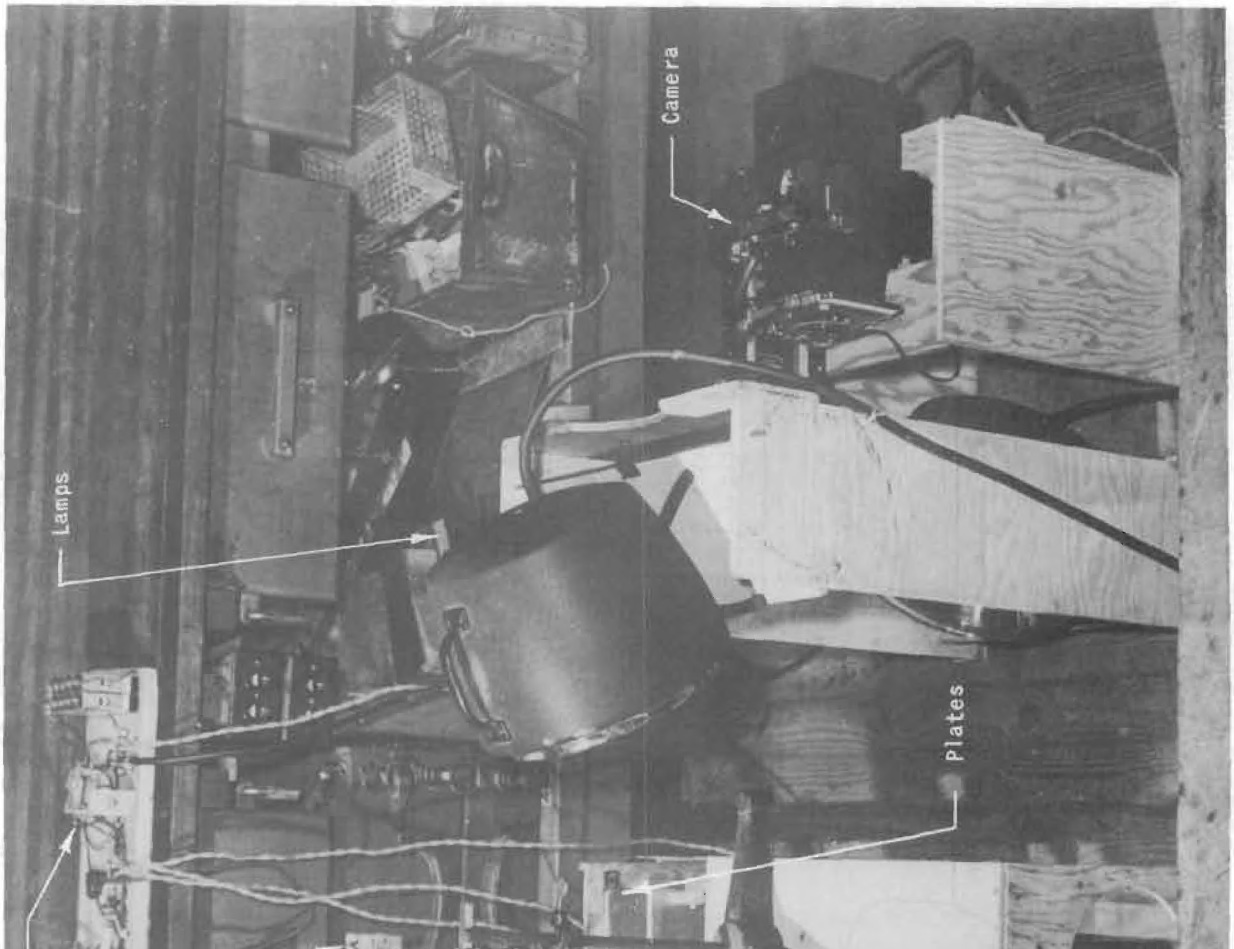
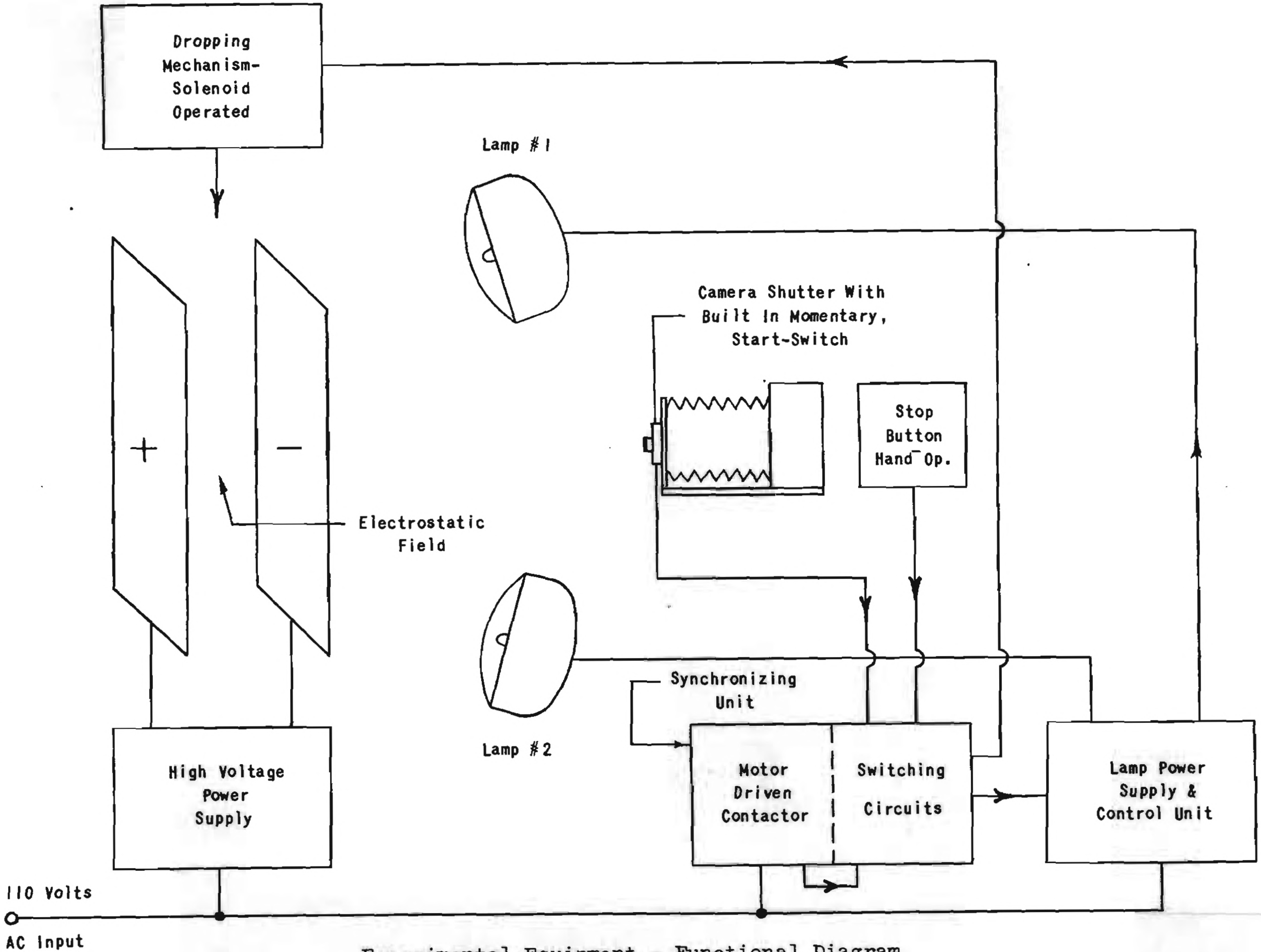


Figure 15. Experimental Equipment - Assembled For Use



Experimental Equipment - Functional Diagram

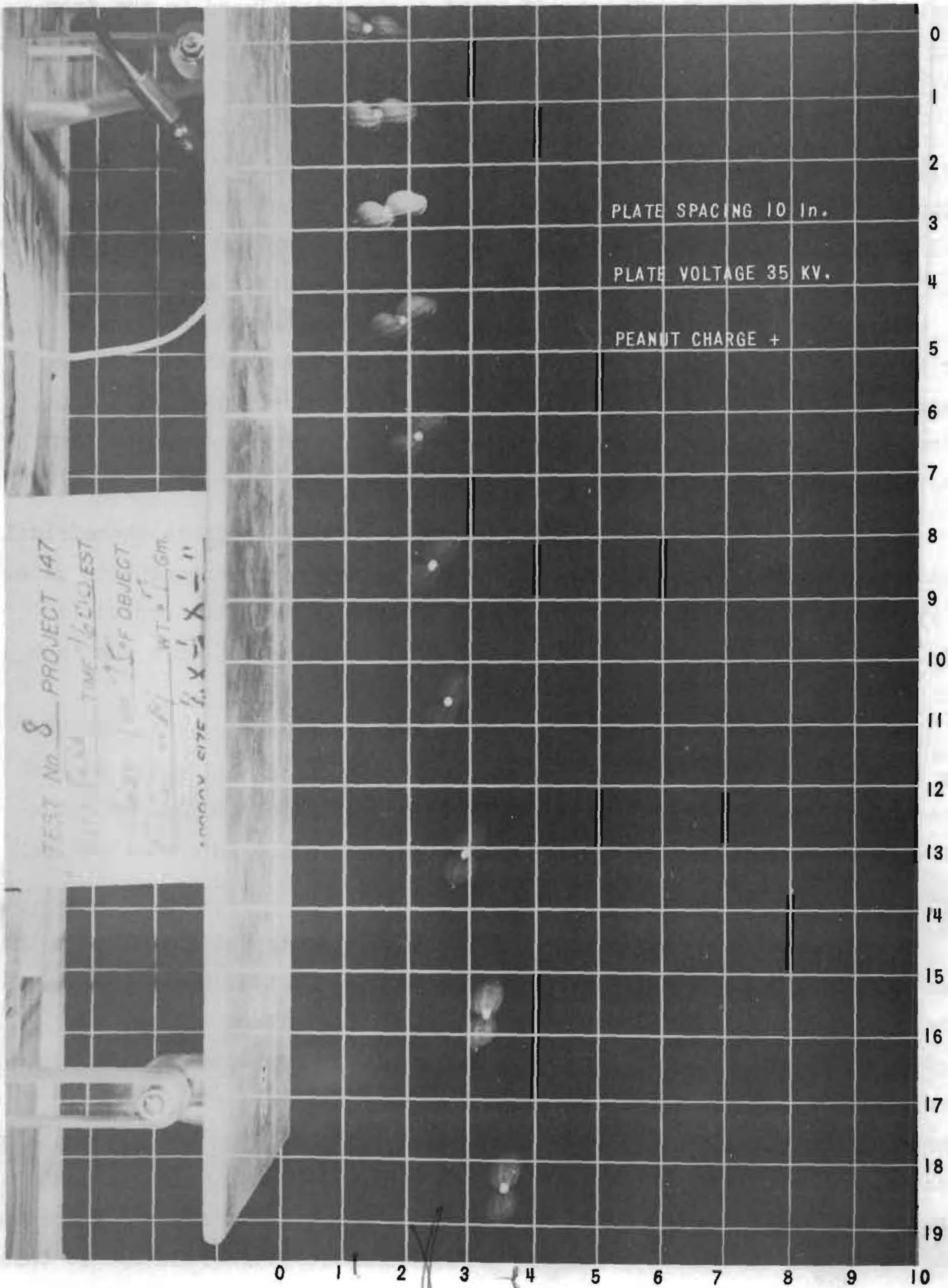
Figure 16.

supply and control unit, the object to be dropped is placed in the dropping mechanism, the rotating contactor is started, the high-voltage is applied to the plates, and the camera adjusted. Upon completion of this preliminary work, the room is darkened, the push button at the camera position is depressed, and the camera shutter tripped. As the shutter is tripped a built-in switch makes a momentary contact and actuates the control unit. The control unit starts the lamps flashing and causes the dropping mechanism to release the object. The camera shutter after being tripped remains open for approximately 3/10 second; the time necessary for the object to travel the length of the plates. When this time has elapsed the push button is released and the lamps cease flashing. Thus, a photographic negative is obtained that shows the object once for each time the lamps flashed during the open time of the shutter.

After processing of the exposed negative, the approximate geometrical center of the object is marked on the negative and an enlargement is made. A typical enlargement is shown in Figure 17; the path of the object (in this case a medium weight peanut) is clearly shown plotted on a one inch per division graph.

The composition of farmers' stock peanuts as taken from the field was carefully checked to determine the various objects that would require separation from the peanuts. The objects listed and classified in Table III were selected as being typical and were used in obtaining deflection data.

A photograph was made of each of the test objects falling through the electric field and the deflections obtained. The plates, placed in the parallel position, were spaced at ten inches, the voltage applied was 35,000 volts, and the object prior to dropping was connected to the positive plate for approximately one minute to acquire a positive charge. Since the charge on the object in its normal state could not be accurately measured, it was considered best to use a charge of known polarity and maximum value obtainable. The length of fall was standarized at 18 inches (the length of the plates), and all deflections are given relative to this length. The diagram of Figure 18 gives the deflections measured for the objects listed in Table III under the test conditions described above.



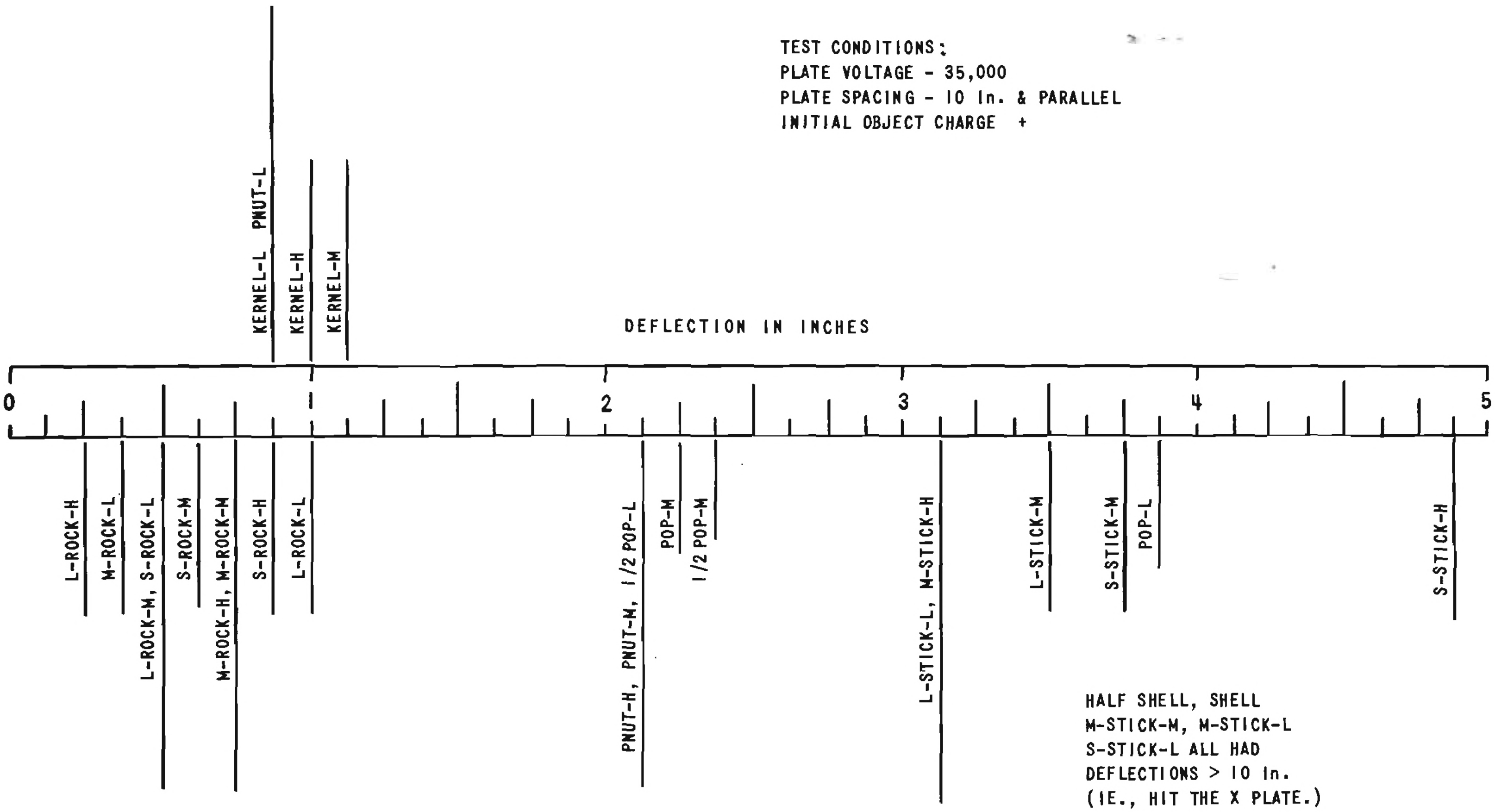
Path Of Falling Peanut In An Electric Field
Figure 17.

TABLE III

TEST OBJECTS TYPICAL OF FARMERS' STOCK PEANUTS*

Object	Weight (gms)	Object	Weight (gms)
Peanut		S-Rock	
-H	1.15	-H	0.30
-M	0.70	-M	0.20
-L	0.50	-L	0.10
Kernel		L-Stick	
-H	0.35	-H	4.20
-M	0.25	-M	1.50
-L	0.10	-L	0.65
Half Pop		M-Stick	
-H	0.80	-H	0.65
-M	0.65	-M	0.25
-L	0.30	-L	0.10
Pop		S-Stick	
-H	0.40	-H	0.95
-M	0.25	-M	0.25
-L	0.05	-L	0.05
L-Rock		Shell	0.05
-H	5.25		
-M	2.65	Half Shell	0.05
-L	1.25		
M-Rock			
-H	1.20		
-M	0.75		
-L	0.40		

*Objects are coded to indicate size and weight. Three classifications are used ahead of the object for size, i.e., large (L), Medium (M), Small (S); three classifications follow the object for weight, i.e., Heavy (H), Medium (M), Light (L). Rocks were classified as to size by standard screens; S--pass 1/4 in. mesh, M--pass 3/8 in. mesh, L--pass 3/4 in. mesh. Other objects were sized by approximation.



Relative Deflections Of Test Objects

Figure 18.

C. Washing and Drying

1. A Study of Moisture, Kernel Temperature, and Drying Time Relationships of Washed Farmers' Stock Peanuts

Samples of Spanish-type farmers' stock peanuts were soaked in cold water for 1/2 minute, then placed in an electrically heated forced draft oven at 150° C., and dried for various lengths of time. The moisture contents of the kernels and of the shells were determined for drying times up to seven minutes and a record was obtained of the temperature rise of the kernels during the drying period.

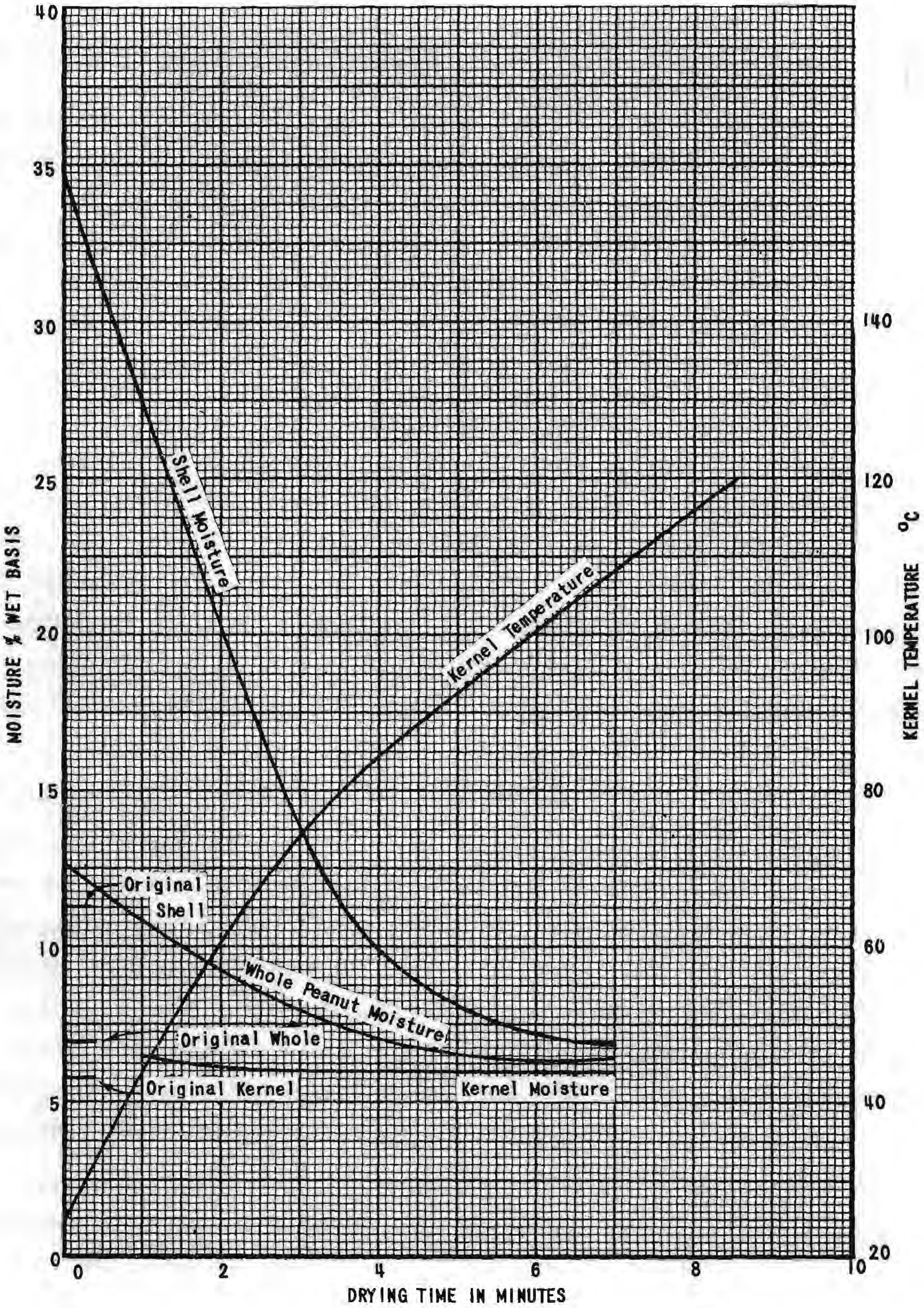
In order to determine the relationship of rise in kernel temperature with time in the oven, thermocouples made of No. 30 iron and constantan wire were used. Each couple was insulated by stringing two unshelled peanuts on the wire above the peanut into which the couple was inserted and cementing the peanuts together and to the wire. Four couples connected in parallel were connected to each of seven terminals on a Leeds and Northrup Speedomax temperature recorder. A "control" couple for recording the oven temperature was connected to the eighth terminal. Readings were recorded automatically, with all eight points being recorded every half minute.

Figure 19 is a plot of moisture contents of shells, kernels, and whole peanuts versus time with a plot of kernel temperature versus time superimposed. Examination of the plots shows that when peanuts are soaked for 1/2 minute that the shells become thoroughly soaked but the kernels absorb less than two per cent water. When the peanuts are dried quickly the shells lose their absorbed water but the kernels retain the water absorbed during the soaking. This leaves the peanut with a low shell moisture which should make shelling easier, and a high kernel moisture which is recommended for prevention of kernel splitting during shelling.*

In order to determine the comparative effect of oven temperature on drying time a method of suspending a wire basket from a triple beam balance into a forced draft oven was used. The washed peanuts were placed in the basket and the weight taken every half minute during the drying period. Figure 20 shows the plots obtained by this method, the plots being based on the calculated pounds of water content per 100 pounds of

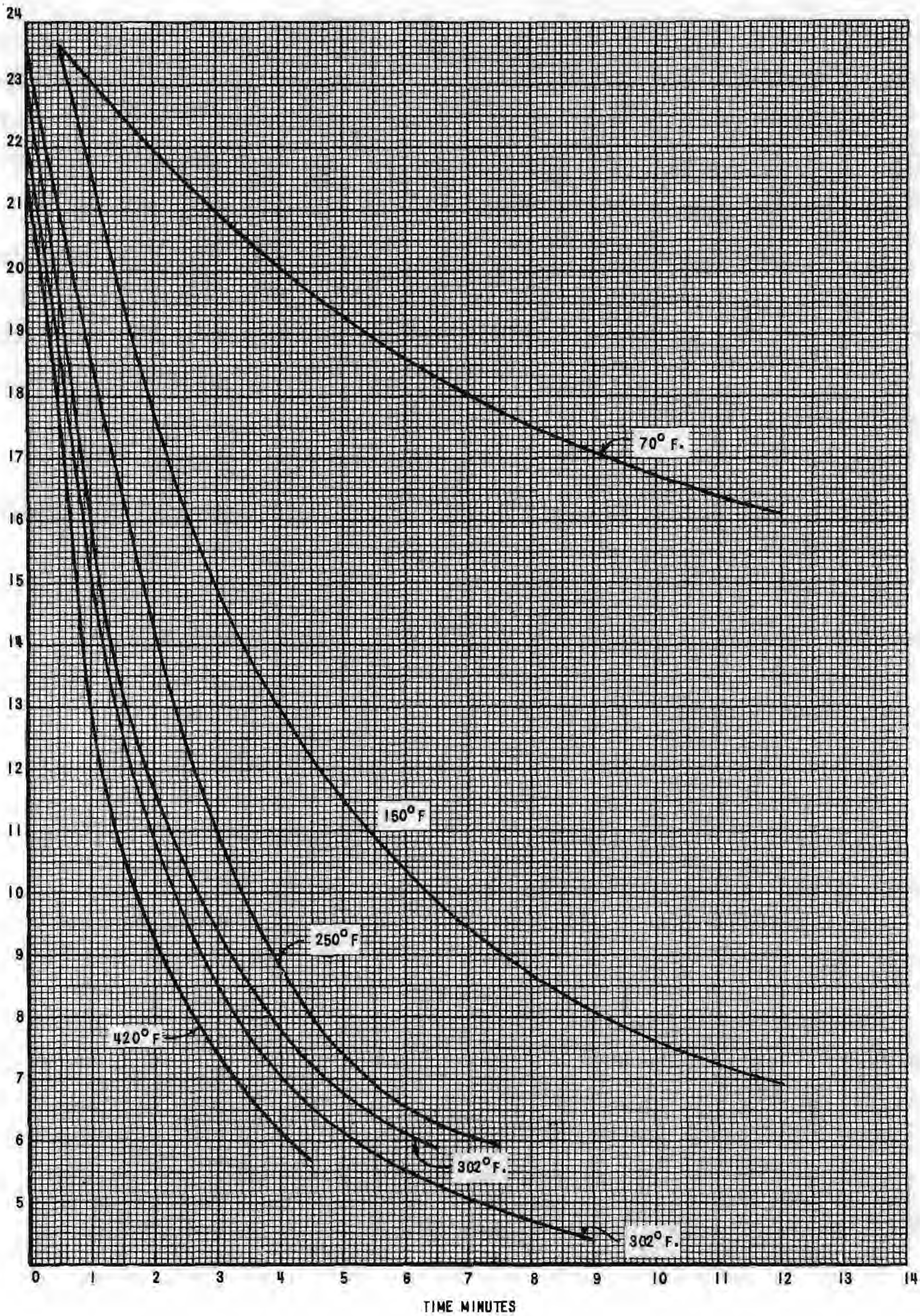
- - - - -

*Beattie, J. H. (see references in Appendix).



Percent Moisture Vs. Time and Kernel Temperature Vs. Time

Figure 19.



Drying Curve Of Washed Peanuts In Forced Draft Oven

Figure 20.

bone-dry peanuts. From the same data a plot of rate of drying versus moisture content was made and can be seen as Figure 21. It is seen that the rate of drying during the constant rate period is affected greatly by the temperature of drying; however, after the peanuts have been dried below the critical moisture content raising the temperature above 150° C. (302° F.) has only a small effect.

As the amount of water to be removed during the drying process determines greatly the time necessary for the drying and the cost of the process, it was felt advisable to construct equipment for continuous washing and drying on a small scale in order that the factors involved might be more readily observed.

Figure 22 shows:

(1) The vibratory feeder by means of which the rate of feed could be easily controlled.

(2) The flotation tank through which the peanuts were carried by water flow and in which the rocks and loose dirt were removed.

(3) The spray screen with needle spray for dislodging and washing dirt from the peanuts.

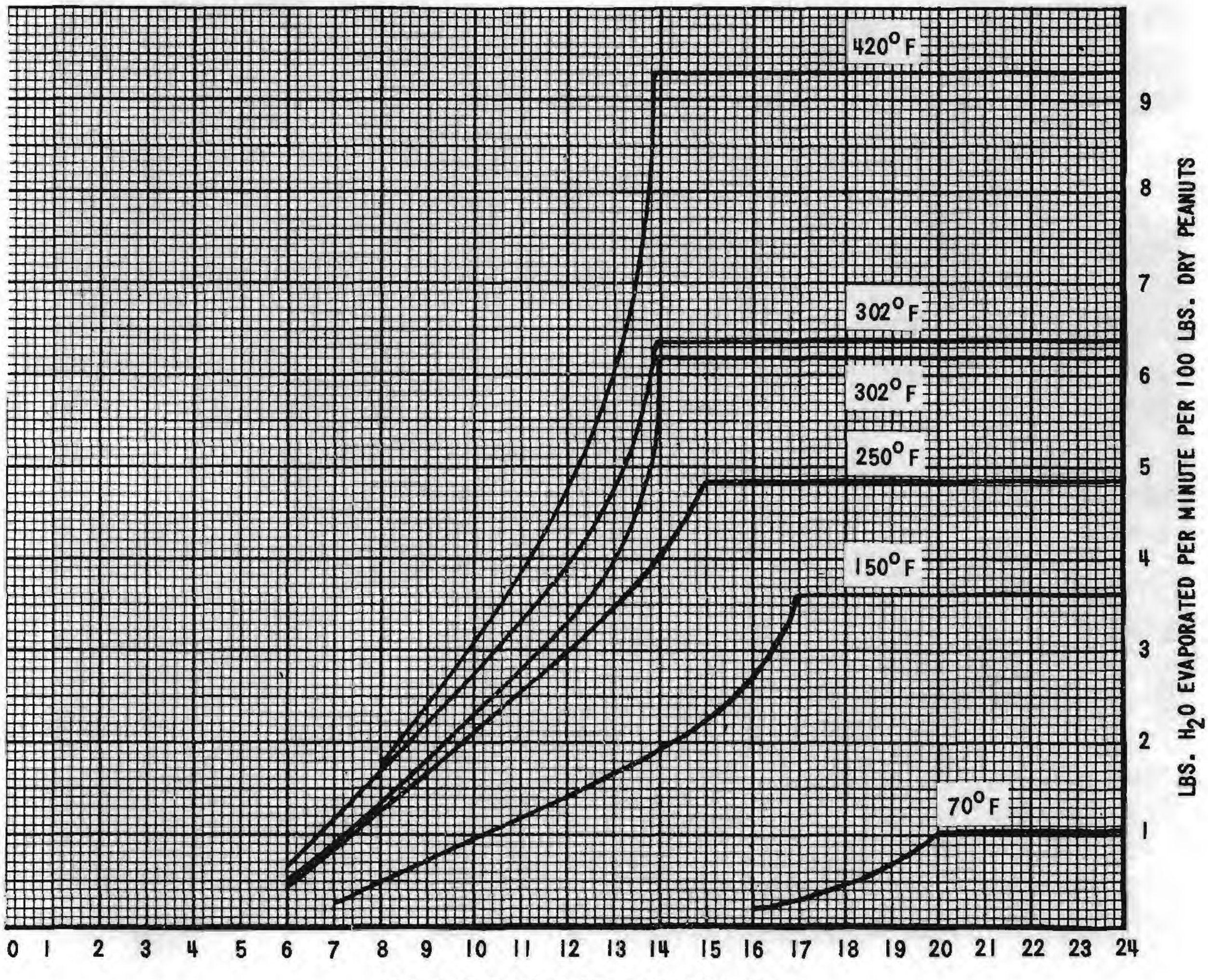
(4) The shaker screen for draining and shaking part of the excess surface water from the washed peanuts.

(5) The air blast preliminary dryer, which was used to blow additional surface moisture from the peanuts.

(6) The direct-fired rotary dryer for removing the excess moisture remaining in the peanuts.

The rate of flow of the material through the process was about 30 pounds per hour as this was the maximum the dryer could handle under the required operating conditions. The washing equipment was operating very much under capacity; however, the results are indicative. A comparison of the results obtained by use of forced-draft ovens and the continuous process with the rotary kiln is made in Table IV.

Two tests using the continuous process were made and samples of the washed and dried peanuts were analyzed for taste and germinability. One test was run at 150° C. with a retention time in the dryer of five minutes. This treatment resulted in a lowering of germination from 85.7 to 80.3 per cent, a loss of 5.4 per cent. The other test was run at 110° C. with a retention time in the dryer of ten minutes, resulting in a ger-



Rate Of Drying Vs. Moisture Content Curves In A Forced Draft Oven

Figure 21.

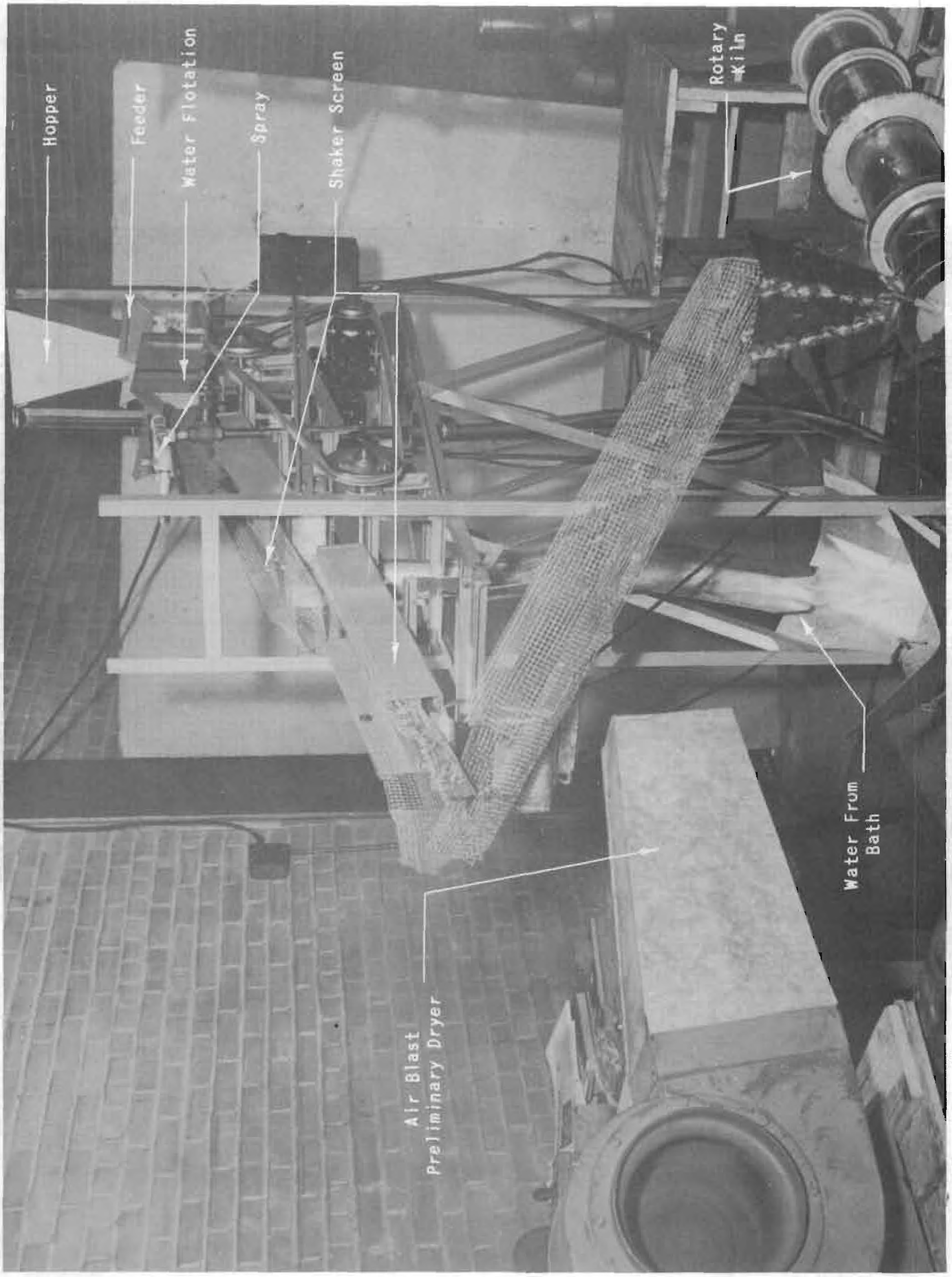


Figure 22. Washing and Drying Equipment

TABLE IV.

COMPARISON OF DATA ON WASHING AND DRYING TESTS

Test No.	Whole Kernel Shells	Original H_2O	H_2O after Wetting*	H_2O Expressed as Lbs. H_2O per 100 Lbs. Dry Material					Drying Time (min)	Drying Temp. (°C.)
				H_2O Absorbed	H_2O after Air Blast	H_2O lost in Air Blast	H_2O after Drying	H_2O lost in Drying		
I**	W	7.63	14.05	6.42	--	--	8.02	6.03	4	150
		"	"	"			6.86	7.19	5	"
		"	"	"			6.77	7.28	7	"
	K	6.26	7.12	0.86	--	--	6.68	0.44	4	"
		"	"	"			6.51	0.61	5	"
		"	"	"			6.55	0.57	7	"
	S	12.57	52.40	39.83	--	--	13.50	38.90	4	"
		"	"	"			8.23	44.17	5	"
		"	"	"			7.65	44.75	7	"
II***	W	8.36	22.05	13.69	--	--	8.77	13.22	7	"
	K	7.07	9.57	2.50	--	--	8.82	0.75	7	"
	S	13.25	71.30	58.05	--	--	7.82	63.48	7	"
III****	W	8.00	18.40	10.40	--	--	8.75	9.65	3-1/2	"
IV*****	W	8.05	19.37	11.32	17.12	2.25	10.15	6.97	5	"
V*****	W	8.05	19.37	11.32	17.12	2.25	10.31	9.06	10	110

*Time of wetting in all cases was 1/2 minute.
**Peanuts with uncracked shells. Forced draft oven, air velocity about two ft./min.
***Peanuts with cracked shells. Forced draft oven, air velocity about two ft./min.
****Peanuts with uncracked shells. Oven air velocity 20 ft./min.
*****Continuous Rotary Dryer. Air velocity 300 ft./min.

mination decrease from 85.7 to 82.3 per cent, a loss of 3.4 per cent. As far as could be determined no deleterious effects were noted as to taste of the peanuts and no visible damage to the peanuts was detected.

From examination of the data it is seen that approximately 15 pounds of water per 100 pounds of dry peanuts is absorbed in the washing process. About ten pounds of this water must be evaporated, while two pounds remain in the kernels and three pounds can be blown off by an air blast. With a 30 per cent heat efficiency of the dryer, 3450 Btu would be required per pound of water evaporated, or 690,000 Btu per ton of bone-dry peanuts processed. At Btu costs of 35 cents per million Btu for natural gas or 90 cents per million for fuel oil, the fuel costs would be 24 cents for gas or 62 cents for fuel oil per ton of peanuts processed. The equipment, labor, and power costs would depend upon the dryer used, the tonnage processed, and the results desired. It is felt that no estimate of value can be made at this time as to costs, as various types of equipment have not been investigated. The loss in germination may be overcome by use of a more efficient dryer and lower drying temperatures. The original cost of a very efficient dryer may, however, be excessively high.

IV. CONCLUSIONS

A. Mechanical Methods

1. Air Blast Cleaner

This method is essentially a fractionation of the product in which major portions of the foreign material are segregated from the peanuts. This separation is effected on 85 to 90 per cent of the available peanuts, which have after this operation a foreign material content of 0.4 per cent. Capacities of five tons per hour per foot of width can be attained. Machinery for this process is not complex; power requirements will be approximately 2.5 hp. per foot of width. No adjustments should be necessary once the machine is placed in operation.

Supplementary processing will be required to give a complete cleaning of the product. This secondary processing will be required for only small percentages of the total product processed.

2. Screening and Sizing

The rotary disc method of screening is nonclogging and has a high efficiency. This screen appears to find best application in the sizing field. Although it requires less space than present screens, it will be higher in first cost.

The V-corrugated slot screen is also nonclogging, and its capacity is equal to, and its efficiency is better than, that of flat screens now in use. The screen can be adjusted in place for size of slot width. The over-all length is shorter than that of flat screens. Fabrication is simple and first cost will be on the order of existing screens. This screen can easily be adapted to present screen frames.

B. Electrostatic Separation

The following observations are based on the operation of the experimental equipment which has thus far been confined to the parallel plate case. The grouping of the objects after deflection, shown in Figure 18, and a comparison of the size and weight of the objects making up the groups suggest that the ratio of surface area to weight would be a convenient parameter for use in separation work. This, of course, is in addition to the dielectric constant which describes the electrical properties of the material. The usefulness of the above ratio would depend largely upon the ease with which the surface area of the objects could be obtained.

Figure 18 also shows the objects to be deflected, which fall into four general groups, i.e., rocks (0 to 1-1/8 in.), whole peanuts (2-1/8 to 2-3/8 in.), sticks (3-1/8 to 5 in.), very light objects (>5 in.). The group spacing of the sticks and the very light objects is such that a practical separation can be realized with the parallel plate experimental arrangement. The spacing of the other groups is not great enough to effect separation in a practical machine. This spacing is too small because of the mechanical interference that will exist between objects as they are fed into and when in the electric field. Increasing the field intensity and hence the horizontal component of force on the object will increase the deflection, the spacing of groups, and the spacing of objects within groups. The "spreading-out" of the objects within the groups is not desirable but can, within limits, be tolerated. The increase in field intensity can be had by the plate voltage being increased or by the plate shape and/or spacing being changed. It is felt that a field strength can be obtained that will provide sufficient group spacing for practical use.

C. Washing and Drying

Satisfactory washing and quick drying of cured farmers' stock peanuts can be accomplished without damage to edible taste qualities. Reduction in germination up to five per cent can be expected with a drying temperature of 150° C. and a retention time in the dryer of five minutes. The temperature of the kernels reaches about 100° C. during the five-minute drying period with drying temperature at 150° C. It is believed that this temperature has a damaging effect on the germinative properties of the peanuts. The kernels are moisturized to a desirable extent during the washing process, and the drying process resolves itself into removing excess moisture from the shells, allowing the kernels to retain the amount absorbed. Determination of cost factors and over-all efficiency cannot be accurately made until further data are obtained.

V. RECOMMENDATIONS

Design and construction of a pilot model cleaner which will include the air blast, rotary disc screen, and the V-corrugated slot screen are now in process. Field tests for this machine and the evaluation of results should be conducted as soon as possible.

The specific application of the electrostatic separation method of cleaning peanuts cannot be immediately recommended until further investigation and tests are conducted. The results indicate that additional research in this field may be profitable.

As the major cost of the washing and drying operation would be that of drying, further effort should be made to control the amount of water absorbed in the washing procedure, possibly by employment of a quicker washing procedure and use of some antiwetting agent on the peanuts before washing. It is believed that more efficient utilization of a cold air blast or use of a hot air blast immediately after washing would remove additional water before the material entered the dryer; thereby, a cut in drying cost and drying time could be achieved. A type of dryer having greater heat efficiency, such as the Roto Louvre, or the columnar type should be tried, together with a trial of two-section drying with high temperature and high air velocity through the constant-rate drying period and a low temperature in the falling rate period.

VI. FUTURE PROGRAM

The scope of this complete project covers a large field. The first year's work having covered cleaning of farmers' stock peanuts. Future work in the phase of mechanical cleaning will include field test of the pilot model air blast cleaner and a study of the application of this machine based on the proved performance and acceptance by shelling plant operators for (1) its use as a precleaner prior to grading, (2) its use as a precleaner prior to storage, (3) its use in normal production, and (4) applications of its components in other shelling plant operations.

Studies will be made to determine the best application of electrostatic cleaning to the industry.

In the phase of washing and drying, the shell brittlizing effect of drying will be determined. Shelling tests will be conducted with attention to shell conditions on shelling efficiency and to kernel moisture effect on splits; the objectives are reduction of splits and increase in capacity.

Design and development of new types of shellers are planned and laboratory and pilot models will be tested.

A general survey of the shelling industry will be made to determine the optimum methods of handling and transporting peanuts. From the industrial engineering viewpoint, a study will cover plant layout, location of equipment, flow of material, storage, and handling.

The picking (for quality) of peanuts will be investigated to determine the possibility of improvement by new designs and/or methods used.

Respectfully submitted:

Thomas A. Elliott,
Project Director

B. W. Carmichael,
Research Engineer

R. A. Martin,
Research Engineer

Approved:

Gerald A. Rosselot, Director
State Engineering Experiment Station

VII. APPENDIX

A. LITERATURE SEARCH

A search of the library literature has been made with the results indicating that very little has been published regarding the methods and problems encountered in the peanut shelling industry.

The Engineering Index was checked for the years 1931 through June, 1950; Industrial Arts Index for the years 1924 through April, 1950; and The Agricultural Index for the years 1922 through 1948 under the heading of peanuts. The following list of references is given as material of interest to persons connected with the peanut shelling industry. No exhaustive literature search was made; however, this list may be considered fairly complete as regards information related to the peanut shelling industry.

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A study of literature describing peanut cleaning equipment and processing machinery now being used in the peanut industry has been made, and what is believed to be a complete list of manufacturers is presented as an aid to persons desiring to obtain information concerning equipment available from these peanut cleaning and processing machinery companies.

1. Cleaners Farmers' Stock
   a. Sutton Steele and Steele
   b. Carter Manufacturing Company
   c. Huntley Manufacturing Company
   d. A. T. Ferrell & Company
   e. Bauer Brothers
   f. S. Howes & Company

2. Shellers
   a. C. R. Medley Company
   b. Pekor Iron Works
   c. D. M. Carter Manufacturing Company
   d. Huntley (Monitor)
   e. Turner Manufacturing Company
   f. Cardwell Machine Company

3. Separators (Screen Type)
   a. D. M. Carter Manufacturing Company
   b. Huntley Manufacturing Company

c. A. T. Ferrell & Company

d. S. Howes & Company

4. Gravity Separators

a. D. M. Carter Manufacturing Company (table)

b. Sutton Steele and Steele, Inc. (table)

c. Bauer Brothers (cyclone)

d. Oliver Manufacturing Company (Rocky Ford, Colorado)(table)

5. Stoners

a. Oliver Manufacturing Company (table)

b. Huntley Manufacturing Company (air lift type)

c. Sutton Steele and Steele, Inc. (table)

6. Picking (for Quality)

a. Electric Sorting Machine Company (electronic)

b. Bickley Manufacturing Company

c. A. T. Ferrell and Company (table)

d. Huntley Manufacturing Company (table)

e. Bauer Brothers (table)

7. Handling Conveyors

a. Continental Gin Company (belt, bucket, screw)

b. Link-Belt

c. Allis-Chalmers

d. A. K. Robins (conveyors, special belting)

e. George E. Stinsman (District Sales, Atlanta) Robins Conveyors, Syntron feeders and vibrators

f. Seedburo Equipment Company (agents)

g. Burrows Equipment Company (agents)

8. Moisture Testers

a. Steinlite (Seedburo Equipment Company)

b. Tag-Heppenstall (C. J. Tagliabue)

c. Universal Moisture Tester (H. C. Gould, Chester, S. C.)

A preliminary search was made by company names only for patents issued since 1930, on equipment now used in the peanut industry. The number of patents located in this way was small but is included as general information.

Patent No.	Year	Company	Equipment
1,914,322	1933	Bickley Mfg. Co.	Device for comparison of colors
1,921,862	1933	Bickley Mfg. Co.	Automatic sorter
1,921,863	1933	Bickley Mfg. Co.	Sorting machine
2,162,392	1938	Carter Mfg. Co.	Peanut cleaner
87,390	1932	Electric Sorting Machine Co. (ESMC)	Lamp housing
1,973,206	1934	ESMC	Sorting apparatus
2,054,319	1936	ESMC	Sorting apparatus
2,054,320	1936	ESMC	Sorting apparatus
2,131,095	1938	ESMC	Sorting homogenous articles
2,131,096	1938	ESMC	Photoelectric sorting devices
2,152,758	1939	ESMC	Sorting machine
2,190,935	1940	ESMC	Sorting machine
2,228,559	1941	ESMC	Lamp housing
2,228,560	1941	ESMC	Compensating circuit for photoelectric amplifiers
2,244,826	1941	ESMC	Sorting machine
2,264,621	1941	ESMC	Selective timing mechanism
2,316,375	1943	ESMC	Sorting machine feeding and ejecting device
2,325,665	1943	ESMC	Sorting machine
1,477,648	1923	J. T. Huston	Peanut shelling machine

The periodicals included in the following list were used as general background material for this work.

1. Government Publications from Bureau of Agricultural Economics, USDA, Washington, D. C.
    a. Agricultural Prices
    b. Agricultural Situation
    c. Crop Production
    d. Demand and Price Situation
    e. Fats and Oils Situation

f. Foreign Crops and Markets

g. Peanut Stocks and Processing

h. Checklist of BAE Publications

2. Production and Marketing Administration

   a. Weekly Peanut Report

3. State Publications

   a. GFA Peanut Association News

   b. Georgia Crop Reporting Service

   c. Georgia Farm Bureau News

   d. Georgia Industrial Progress

4. Trade and Other Publications

   a. Peanut Journal and Nut World

   b. Fifth and Sixth District Federal Reserve Bank Monthly Review

   c. National Peanut Council and Shellers Association Publications

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Anon., "Ronsburg Electrostatic Spraying and Detearing Process." Engineering 166, 427 (1948).

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Frass, F., Notes on Drying for Economic Separation of Particles. Am. Inst. Min. and Met. Engrs. Tech. Pub. No. 2257 (for meeting Feb. 1948). Also Mining Technology, 14 (Nov. 1947).

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Frass, F. and Ralston, O. C., "Electrostatic Separation of Solids." Ind. Eng. Chem. 32, No. 5, 600 (1940).

Gillson, J. L., Electrostatic Methods of Concentration. Chemical Engineers Handbook (Perry) Second Edition, 1941, pp. 1740-43.

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Sutton, H. M. and Jarmon, G. E., Paper Presented at Meeting of American Institute of Mining and Met. Eng. (Feb. 1940).

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Bigelow, Leroy E., U. S. 2,160,822, "Device for Dry Separation of Precious Metals from Finely Divided Material."

Fahrenwald, Frank A., Parkinson, Norman Frederick, and Barnes, George Henry, U. S. 2,180,804 (to International Titanium Limited), "Process of Electrostatic Separation."

Gates, Elmer, U. S. 653,343 (to Theodore J. Mayer), "Electrostatic Separation."

Grave, Georg, U. S. 2,072,501 (to American Lurgi Corp.), "Apparatus for Electrostatic Separation."

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Johnson, Fred R., U. S. 2,154,682, "Method and Apparatus for Separating Materials."

Johnson, Fred Rothwell, U. S. 1,744,967, "Art of Separating and Apparatus Therefor."

Johnson, Herbert B., U. S. 2,135,716 (to Ritter Products Corp.), "Method and Apparatus for Separating Foodstuff of the Nature of Cocoa Beans."

Kraus, Jakob, U. S. 1,179,937, "Method and Apparatus for Separating and Cleaning Materials in an Electrostatic Field."

Kraus, Jakob, U. S. 1,222,305, "Electrostatic Separator for Inflammable Materials."

Lawson, John L., U. S. 880,891, "Electrical Purification of Flour, Grain, etc."

Masse, Thomas J., U. S. 2,445,229, "Method and Apparatus for Electrostatically Separating Particles Having Different Electrical Particles."

O'Brien, Brian, U. S. 2,168,681, "Method and Apparatus for Separating Materials."

Sutton, Henry M., Steele, Walter L., and Steele, Edwin G., U. S. 813,063, "Process of Separating Substances of Different Dielectric Capacities."

Sutton, Henry M., Steele, Walter L., and Steele, Edwin G., U. S. 1,017,701, February 20, 1912, "Electrostatic Separator."

Sutton, Henry M., Steele, Walter L., and Steele, Edwin G., U. S. 1,020,063, Mar. 12, 1912, "Process of Electrostatic Separation."

Sutton, Henry M. and Steele, Edwin G., U. S. 2,187,637, "Apparatus for the Electrostatic Separation of Particles Having Different Electrical Susceptibilities."

Wiegard, Edwin L., U. S. 2,213,510, "Apparatus for Classification and Separation of Material Particles."

B. THE EFFECT OF AIR STREAMS ON PARTICLES

1. List of Symbols

A. . . . . Projected area of particle, square feet.

D. . . . . Diameter, ft.

f. . . . . Drag Coefficient.

g. . . . . Gravitational acceleration, taken as the standard value, 32.2 ft./sec.^{2}

R. . . . . Reynolds number.

S.	Distance traveled by particle, ft.
t.	Time, sec.
V.	Absolute velocity, ft./sec.
v.	Relative velocity of particle to air, ft./sec.
w.	Weight of particle, lb.
$()_v$	Refers to the verticle direction.
$()_h$	Refers to the horizontal direction.
$()_p$	Refers to the particle.
$()_a$	Refers to the air.
ρ	Mass density, lb. x sec.^{2}/ft.^{4}
μ	Absolute viscosity to air, lb./sec. x ft.^{2}

2. The Effect of a Horizontal Air Stream on Particles

When a particle drops into still air and the density of particle is much higher than that of air, by the second law of motion.

$$\frac{W}{g}\frac{dV_p}{dt} = W - f/2\,\rho_a A_p V_p^{\,2}.$$

The drag coefficient f, verified by a number of different authorities,[1] is a function of Reynolds number, as shown in Figure 23. To make a very close assumption, the relation of f versus R for peanuts is between that for sphere and cylinder of infinite length. Wadell[2] has explained how the sphericity and circularity of irregular shape particles affect the coefficient of air resistance. Rearranging the above equation yields:

$$dt = \frac{dV_p}{g - fA_p\rho_a V_p^{\,2} g/2W}.$$

To start at rest, $t = 0$, $V_p = 0$.

$$t = \int_0^{V_p} \frac{dV_p}{g - fA_p\rho_a V_p^{\,2} g/2W}. \qquad (1)$$

By definition,

$$R = vD_p\,\rho_a/\mu a.$$

- - - - -

(1) Croft, Huber O., Therodynamics, Fluid Flow & Heat Transmission. Mc-Graw Hill Book Co., New York, 1938.
Hunsaker and Rightmire, Engineering Application of Fluid Mechanics. McGraw Hill Book Co., New York, 1947.

(2) Wadell, Hakon, The Coefficient of Resistance as A Function of Reynolds Number for Solids of Various Shapes. J. Franklin Inst., 217, 1934, pp. 459-90.

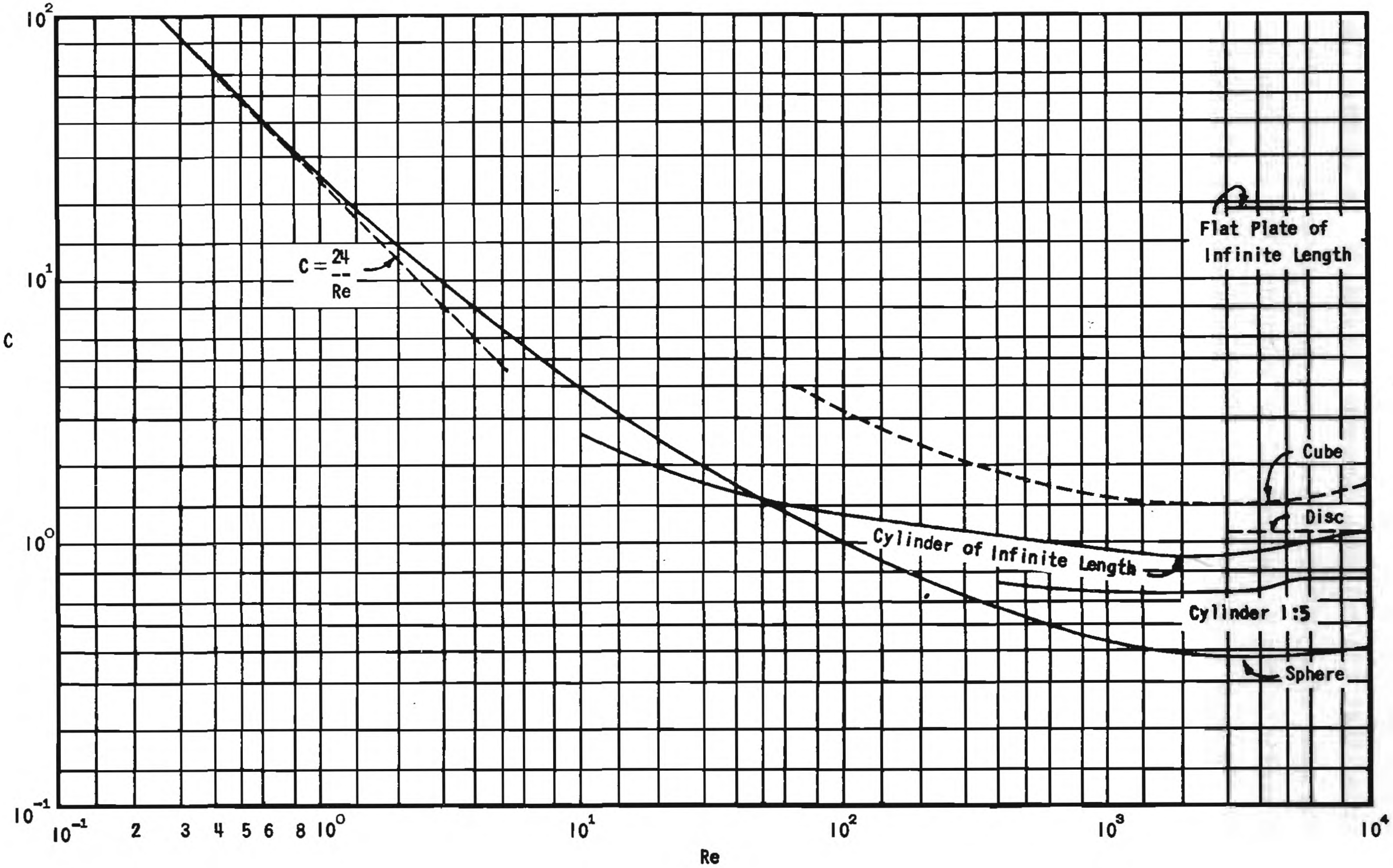


Figure 23.

Drag Coefficient Versus Reynolds

At room temperature, ρ_a and μ_a are practically constant. Then, the drag coefficient becomes a function of the diameter and the mass of a particle, provided that the relation between f and R is known. The diameter and the mass of a spherical particle being assumed, the t-v relation of the particle can be determined by equation (1), as shown in Figure 24. The distance traveled by a falling particle from its rest position is:

$$S = \int_0^t V_p dt \,.$$

For cleaning farmers' stock peanuts the t-S and v-S relations of all particles (peanuts, sticks, and stones[3]) are very close to that of a free falling body in vacuum, if the tip of feeder is less than one foot above the air stream. All the particles will fall into the air stream in good order, and the stones will not strike the sticks or the peanuts. This phenomenon is verified by the aid of high-speed movies. The amount of feeding is restricted to a thin layer by the vortex formation which occurs behind the particle, and the rate of feed will normally be restricted to the velocity of a free falling body.

When a particle enters the horizontal air stream, the equations for two-dimensional motion are:

$$\frac{W}{g} \frac{d(V_p)_h}{dt} = \frac{\rho_a f A_p v v_h}{2} \,,$$

$$\frac{W}{g} \frac{d(V_p)_v}{dt} = W - \frac{\rho_a f A_p v v_v}{2}$$

where

$$v^2 = v_h^2 + v_v^2 \,,$$

$$(V_p)_v = v_v \,;$$

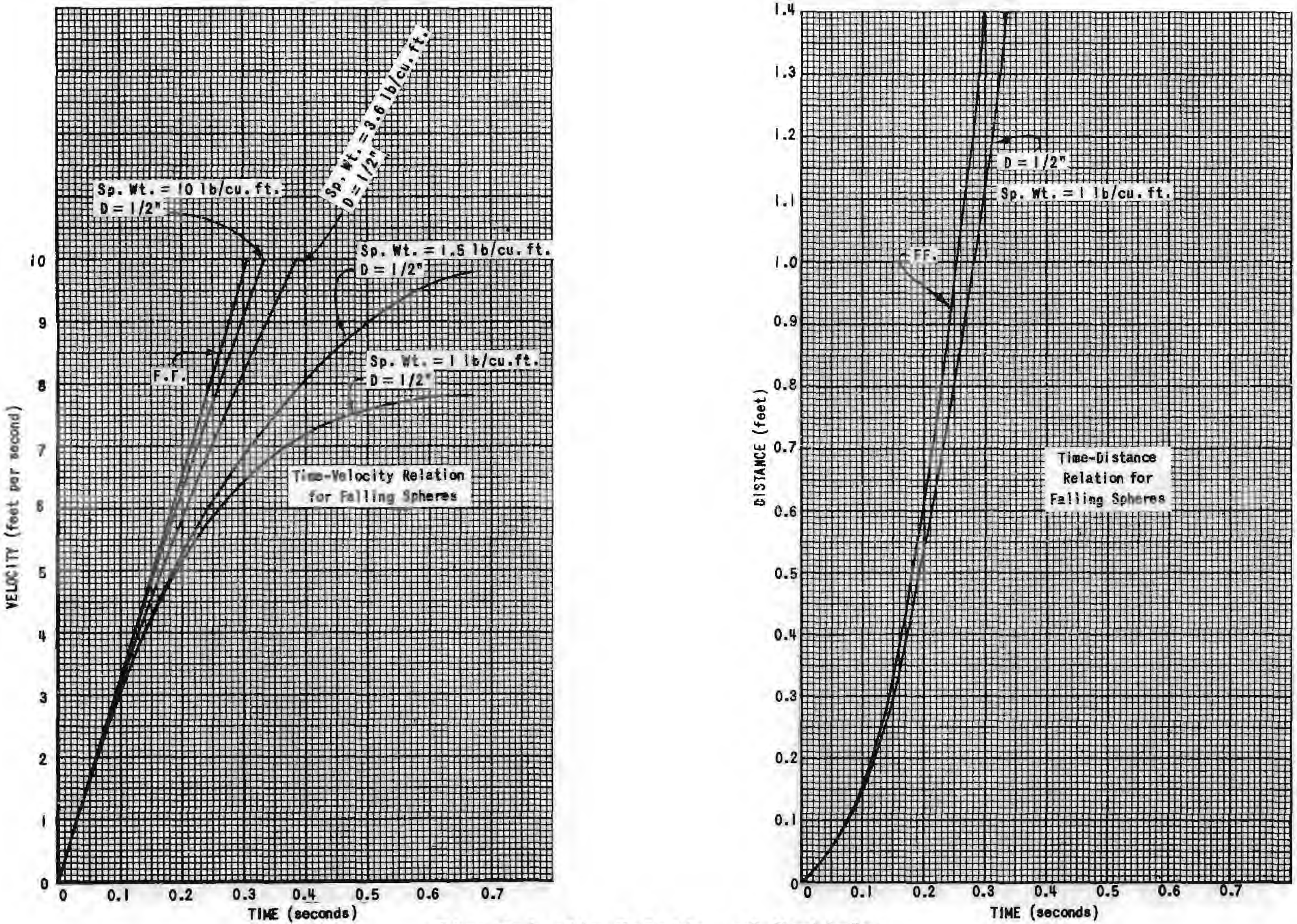
and

$$(V_p)_h = V_a - v_h \,.$$

If V_a is assumed constant as in Figure 25, rearranging the above equations gives:

- - - - -

(3) The average density of stone is 155 lb./ft.^{3}, that of peanut is 42 lb./ft.^{3}, and that of sticks is 30 lb./ft.^{3} (These densities should not be confused with bulk densities, which include voids.)



Time Velocity Relation of Particle.

Figure 24.

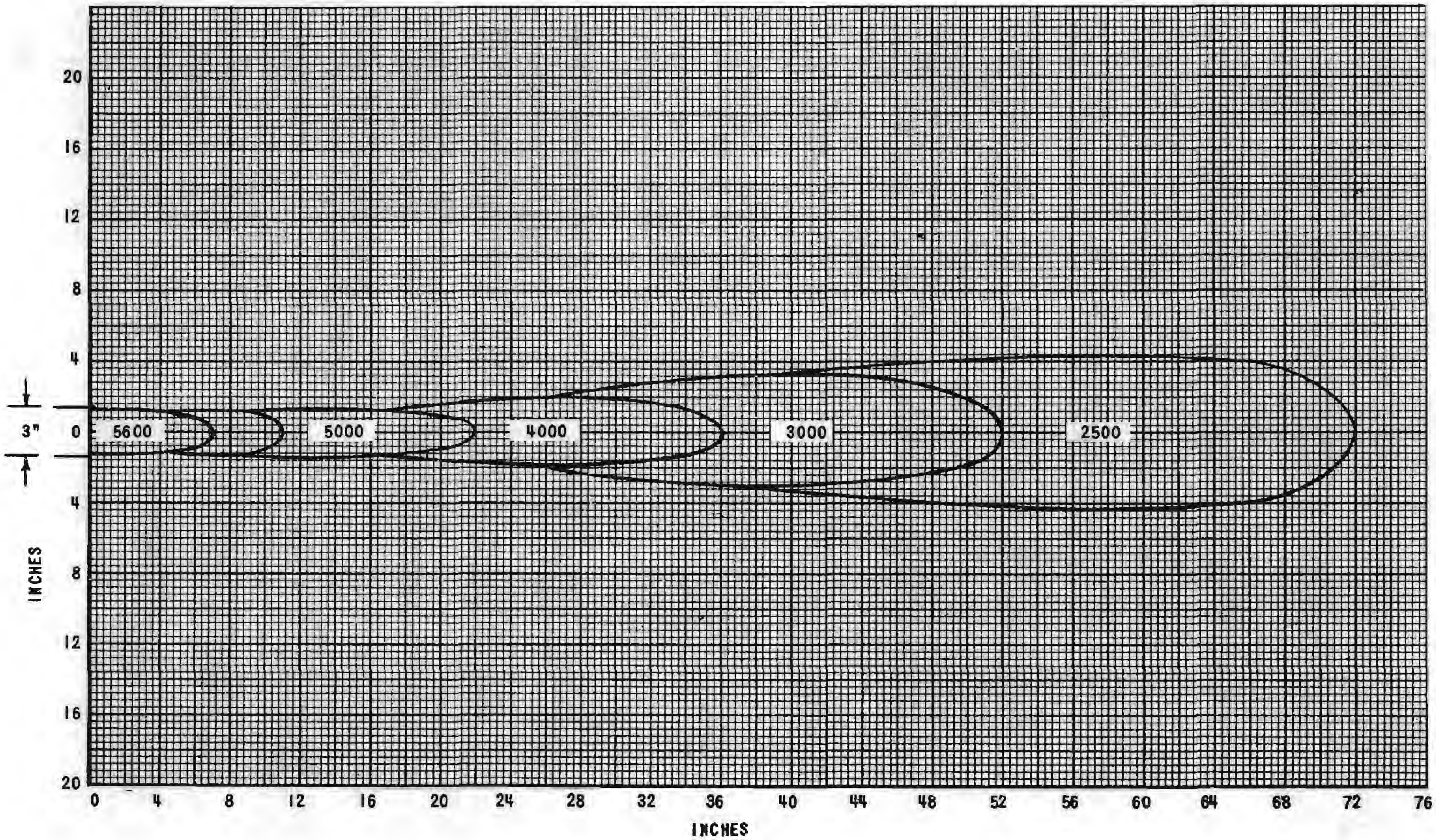


Figure 25.

Velocity Distribution of An Air Stream from a 3" Nozzle.

$$\int_{t_1}^{t_2} dt = \int_{(v_h)_1}^{(v_h)_2} \frac{-dv_h}{gf\,\rho_a A_p v v_h/2W}, \qquad (3)$$

$$\int_{t_1}^{t_2} dt = \int_{(v_v)_1}^{(v_v)_2} \frac{dv_v}{g - gf\,\rho_a A_p v v_v/2W}. \qquad (4)$$

If it be assumed that the absolute air velocity is 100 ft./sec., the height from the feeder tip to the air stream is one foot and the depth of nozzle is three inches; from equations (3) and (4), the absolute velocity components of a peanut, both vertical and horizontal, are very close to eight ft./sec. Observation of the high-speed movies proved this correct.

Explanation of equations (3) and (4) reveals that fA_p/W is the basic factor which causes the separation of particles by horizontal air blast. The absolute velocity of particle leaving the air stream is also controlled by the time of the particle passing through the air stream, the absolute velocity of air, and the initial velocity of the particle entering the air stream. Thus, variation of the depth of nozzle, absolute air velocity, and the height from the tip of the feeder to the air stream will cause different separations.

In fluid, when a particle is disturbed from a condition of equilibrium, stability is the property of the particle which causes forces or moments to act to restore it to its original conditions.[4] Peanuts, sticks, and stones are unstable, dynamically and statically, when they move in a horizontal air stream. Thus, a part of the energy is consumed in rotating the particle. The frontal cross-section area of particle, A_p, and drag coefficient, f, also change for any unspherical particle. Dropping the same peanut into an air stream will illustrate that the path of the peanut is different for every drop. From observation, the distribution of peanuts after horizontal air blast is $\pm$ 20 per cent of the mean horizontal distance traveled by the peanuts (for nozzles three to ten inches deep). Since it is undesirable to have the peanuts wildly distributed, the mean horizontal distance traveled by the peanuts should be limited to four feet or less.

- - - - -

(4) Den Hartog, J. P., Mechanical Vibration. McGraw Hill Book Company, New York, 1947, p. 350.

3. The Effect of a Vertical Air Stream on Particles

Terminal velocity and the velocity of an upward air stream to float the particle are two different things. In determination of the floating velocity, the air stream may be in a turbulent condition, while in determination of the terminal velocity the air is still. But they are approximately the same. The following equation could be used to determine the floating velocity, V_f, of a particle in the air:

$$V_f = \sqrt{\frac{2W}{fA_p \rho_a}} . \qquad (5)$$

From the above equation, the terminal velocity of an average peanut is found to be 1,800 ft./min. For sticks, the value of f is around 1.2 (Figure 23); an approximate equation might be used:

$$V_f = 130\sqrt{D}.$$

For a big stick of 3/8 inch diameter, the floating velocity would be 1,370 ft./min. The stability of a particle floating by an upward air stream is much better than it is in the horizontal air blast.

By test, the following data have been obtained:

Item	Floating Velocity
Peanuts	1,600 to 2,100 ft./min.
Kernels	1,700 to 2,200 ft./min.
Sticks, under 13/32 in. dia.	500 to 1,300 ft./min.
Sticks, over 13/32 in. dia.	1,100 to 1,700 ft./min.
Stones, pass 1/4 in. screen; not pass 3/8 in. screen	2,100 to 3,100 ft./min.

For practical application, the air floating method is good to separate the stones from the peanuts; but it is hard to separate the heavy and big sticks in this manner, and in either case large capacities cannot be accommodated.

C. FIELD TRIPS

Field trips for the study of existing methods and machinery used in shelling plants have been made and the following plants have been visited.

Kroger Company	Montezuma, Georgia
McKlesky Cotton Oil & Peanut Mills	Americus, Georgia
Bain Shelling Plant	Albany, Georgia

Newton Peanut Company	Newton, Georgia
Camilla Cotton Oil Company	Camilla, Georgia
Georgia Peanut Company	Moultrie, Georgia
Pelham Oil & Fertilizer Company	Pelham, Georgia
Stevens Industries	Dawson, Georgia
Tom Huston Peanut Plant	Columbus, Georgia
H. C. Williams Peanut Company	Ashburn, Georgia
Farmers Peanut Company	Cairo, Georgia
Planters Products Company	Donaldsville, Georgia
Dothan Oil Mill Company	Dothan, Alabama
Greenwood Products Company	Graceville, Florida
Headland Peanut Company	Headland, Alabama
Farmers Gin & Warehouse Company	Blakely, Georgia
Miller Peanut Company	Leary, Georgia
Lone Star Peanut Company	Dallas, Texas

The above represent a cross section of all the peanut plants in the area, ranging from the largest to the smallest. The plants were observed mainly as to machines used and layout of the machinery.

In addition to these Peanut Shelling Plants, visits have been made to the following equipment manufacturers:

Lilliston Company	Albany, Georgia
Medley Manufacturing Company	Columbus, Georgia
Sutton Steele & Steele	Dallas, Texas

D. STAFF

During the period July 1, 1949-June 30, 1950, the following personnel have been associated in the stated capacities.

Experimental Research and Development

*Thomas A. Elliot, Research Engineer, Project Director (July 1, 1949-)
*Ben W. Carmichael, Research Engineer, (July 1, 1949-)
*James C. S. Chou, Research Assistant (February 1, 1950-)
Roy A. Martin, Research Engineer (April 1, 1950-)
Robert L. Allen, Associate Professor (July 1, 1949-)
M. A. Honnell, Research Associate Professor (October 1, 1949-)

- - - - -

*Salaried personnel; all others were part time.

Frank D. Stringer, Research Assistant (May 1, 1950-)

Lyman H. Eddy, Technician (December 1, 1949-February 1, 1950)

James M. Norman, Technician (October 1, 1949-December 1, 1949)

Service Groups

Mechanical Design Section:

R. A. Hall, Research Engineer

Wm. M. Jackson, Research Assistant

Photographic and Reproduction Laboratory:

James E. Garrett, Research Assistant

George F. Brooks, Technician

L. C. Prouse, Technician

John H. Baker, Research Engineer

Technical Information Division:

Ben H. Weil, Chief

Marjorie A. Maertz, Research Assistant

Agnes C. Redfearn, Research Assistant

Maryolive L. Reisman, Typist

Shop:

Earl R. Hay, Sr., Machinist

Secretary:

Melba White

Other Contributors

The following personnel who are members of the Georgia Experiment Station, Experiment, Georgia have contributed much to the progress to date in the way of advice, information, resolution of problems, and the conduct of special tests. The authors wish to give them full credit for the assistance received and the fine spirit of cooperation which has been maintained by them.

W. K. Bailey	N. M. Penny
J. G. Futral	T. A. Pickett

Georgia Institute of Technology

STATE ENGINEERING EXPERIMENT STATION

Machinery For Cleaning Farmers Stock Peanuts

T.A. Elliott and B.W. Carmichael

State Engineering Experiment Station
cooperating with
Georgia Experiment Station

Atlanta, Georgia

July 1, 1951

Georgia Institute of Technology
STATE ENGINEERING EXPERIMENT STATION
Atlanta, Georgia

ANNUAL PROGRESS REPORT

PROJECT NO. 147

EFFICIENT PICKING, TRANSPORTING, HANDLING STORING, AND SHELLING OF FARMERS' STOCK PEANUTS

Prepared for

STATE ENGINEERING EXPERIMENT STATION
and
GEORGIA EXPERIMENT STATION

By

T. A. ELLIOTT and B. W. CARMICHAEL

JULY 1, 1951

FOREWORD

This report covers the second year of work on Project 147, "Efficient Picking, Transporting, Handling, Storing, and Shelling of Farmers' Stock Peanuts." The research reported herein was supported both by funds provided by the Georgia-Florida-Alabama Peanut Association, Camilla, Georgia, and by an equal amount of funds authorized under Title II of the Research and Marketing Act of 1946. The developmental work and field installations as well as the laboratory work were conducted by the State Engineering Experiment Station of the Georgia Institute of Technology, Atlanta, Georgia. The project is conducted in cooperation with the Department of Agricultural Economics, Georgia Experiment Station, Experiment, Georgia, Project RM:C-411, ES-3.

The initial phase conducted during the fiscal year 1949-50, was described in a report entitled "Cleaning Farmers' Stock Peanuts," dated July 1, 1950.

During the fiscal year 1950-51, experimental pilot models of two machines developed during the first year were constructed, installed in shelling plants in the field, and tested under production conditions. Concurrently laboratory research was conducted on other phases of the project.

The scope of the project is broad and covers many problems of vital interest to the industry. This report should be considered only as a statement of the progress of work accomplished in 1950-51. It is believed that the success which has been achieved in solution of some of the problems of the peanut shelling industry by application of engineering research methods will be extended to other problems of the industry that exist today and to those that no doubt will arise in the future.

Comments and suggestions from individual members of the peanut industry have been helpful and will be appreciated as this work continues.

W. T. Fullilove, Head
Department of Agricultural Economics
Georgia Experiment Station
Experiment, Georgia

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I. SUMMARY

During the fiscal year ended June 30, 1951, work on Project 147 was directed toward the further development and in-plant testing of peanut cleaning and sizing machines devised in the previous year, and toward laboratory study of means for sized shelling and quality picking. A full-scale prototype of the air-blast cleaner and slot screen combination was built, installed in a shelling plant and tested under production conditions. A similar in-plant testing procedure was followed in the case of the rotary disc screen. The development work leading up to the in-plant test programs was described in some detail in a report entitled "Cleaning Farmers' Stock Peanuts," dated July 1, 1950.

In the year just past, laboratory investigations were conducted on other aspects of the project. These included study of methods for sized shelling, the development of a vacuum-operated aid to quality picking and the design of an automatic, electronic quality picker.

A. The Air-Blast Cleaner and Slot Screen

An air-blast cleaner and slot screen were built and installed at the Red Diamond Mills, Cordele, Georgia. In conjunction with a sand screen and stoner, this combination was tested for efficiency in cleaning loads high in foreign material (FM) prior to grading.

In these tests, loads with an average FM of 17.73 per cent were reduced to an average FM content of 2.84 per cent. Loads with an average FM of 7.4 per cent were reduced to an average FM of 1.13 per cent. Loads which had been previously processed over a farmer's stock pre-cleaner to an average of 1.36 per cent FM (stick content only) were further reduced to a FM content of 0.28 per cent by the air blast. All of the test loads were run at a rate of 12-15 tons per hour. Utilizing the air-blast as a separator and segregating the heavy and light peanuts in an 80-20 per cent weight group resulted in an effective sizing which permitted the light portion to be routed directly to a #2 Sheller. Furthermore, damage in the heavy portion was reduced in some cases by one to three per cent, and a FM content of less than 0.6 per cent was obtained in this portion.

Results to date indicate that the air-blast cleaner and slot screen combination does not clog and requires no labor for adjustment or cleaning during operation. The combination seems quite versatile, and it promises the following applications:

1. For the Farmer
   a. As an integral adjunct to his combine and threshing machine;
   b. As a separate unit to clean and up-grade his product prior to sale; and
2. For the Shelling Plant
   a. As a precleaner prior to grading;
   b. As a primary precleaner prior to processing; and
   c. As a supplemental cleaner after preliminary cleaning by methods now employed.

The cost of the air-blast cleaner and slot screen combination should be moderate, as indicated by the fact that the prototype at Cordele was installed, complete with drives, for about $1,050.

B. The Rotary Disc Screen

A rotary disc screen was built and installed at the East Georgia Peanut Company to test its ability to size peanuts in the shell.

Capacities of two tons per hour per foot of width were attained. Mechanical damage to the product has not been completely determined, but preliminary data indicate two per cent less damage by this machine than in a reel-type sizer.

The rotary disc screen completely removed sand from prepared feeds with sand contents as high as 20 per cent. It separated 99 per cent of all loose kernels from the unshelled farmers' stock peanuts.

C. Vacuum Quality Picking

Laboratory tests on a suction system for use as an aid in manual quality picking show a 17 per cent labor savings possible by the use of this method.

D. Automatic Electronic Quality Picker

Laboratory tests and design work on an automatic electronic picker are being conducted. Preliminary results indicate that a low-cost machine for this purpose can be built.

E. Sized Shelling

The small laboratory model rotary disc screen was utilized to obtain several portions of closely sized unshelled peanuts, each portion containing peanuts of approximately the same diameter. Shelling tests were then conducted with each portion and the effect of sheller grate size used on shelling rate, shelling percentage, and percentage of kernels split was determined.

The tests indicated that by sizing of peanuts before shelling and by use of the proper size sheller grates that the percentage of kernels split during the shelling operation could be reduced one to two per cent from the percentage now split using conventional shelling methods. An overall increase of efficiency in the shelling operation was indicated.

II. AIR-BLAST CLEANER AND SLOT SCREEN COMBINATION

A. Introduction

For some time the management of the Red Diamond Mills at Cordele, Georgia, had felt that cleaning prior to grading would be desirable in cases where loads were high in foreign material or where there was a difference in opinion between farmer and purchaser over the accuracy of the grading procedure. Therefore, it was decided to install a prototype air-blast cleaner and slot screen combination at the Red Diamond Mills for testing as a precleaner prior to grading. This equipment, together with a sand screen (used as a feeding device) and a Sutton, Steele & Steele stoner, was built and installed in the building pictured in Figure 1. The Red Diamond Mills paid the costs of labor and materials, while the Engineering Experiment Station provided the necessary engineering supervision.

The use of this equipment was offered to farmers as an optional, free-of-charge service prior to grading. In addition to its use to settle differences of opinion at the time of initial grading, it was used by Red Diamond Mills to preclean, before storage, loads high in foreign material content and by other shellers for cleaning peanuts in the shell and settling disputes over variations in the "in" and "out" grades of loads of peanuts which had been in storage.

B. Experimental Work and Discussion

1. Building and Machinery Layout

The building in which the cleaner was installed was 20 feet square and had 13 feet of head room. The upper section of the building contained a six-ton feed bin which could be loaded from a dump pit by means of a bucket-type elevator. An adjustable gate permitted the use

Figure 1. House for Experimental Pilot Model Air-Blast Cleaner.

of the elevator both for filling the bin with unprocessed peanuts and for returning the cleaned peanuts via the gravity chute to the truck. The building is shown in Figure 1.

A schematic diagram of the cleaning machinery is shown in Figure 2. The peanuts were fed from the storage bin to a double screen. The upper layer of this screen was a large-hole screen which retained the larger pieces of trash. The lower layer was a sand screen which spread the nuts as it fed them into the feed chute. The action of these screens is readily apparent in Figure 3. The feed chute directed the peanuts into the horizontal air stream emerging from the nozzle. The nozzle, the air chamber, and the axial flow blower are shown in Figure 4. A frontal view of the nozzle can be seen in Figure 5, which also shows the egg-crate straighteners for the air stream. As the peanuts and trash fall through the air stream, their paths diverge sufficiently to be separated into three general groups. From the schematic diagram, it can be seen that the heavy peanuts and stones fall into the first compartment and onto a belt which carries them to the stoner shown in Figure 6. These peanuts travel from the stoner to the dump pit through a gravity chute. The light peanuts and the sticks are deflected into the second compartment and from it they fall onto the corrugated slot screen, shown in Figure 7, which separates out the hulls, pops, and most of the sticks. The light peanuts are carried by belt conveyor to the pit where they are mixed with the heavy nuts before being elevated and discharged to a waiting truck. Almost any desired split between the heavy peanuts and the light ones can be achieved by raising or lowering the adjustable deflection plate which separates the first and second compartments.

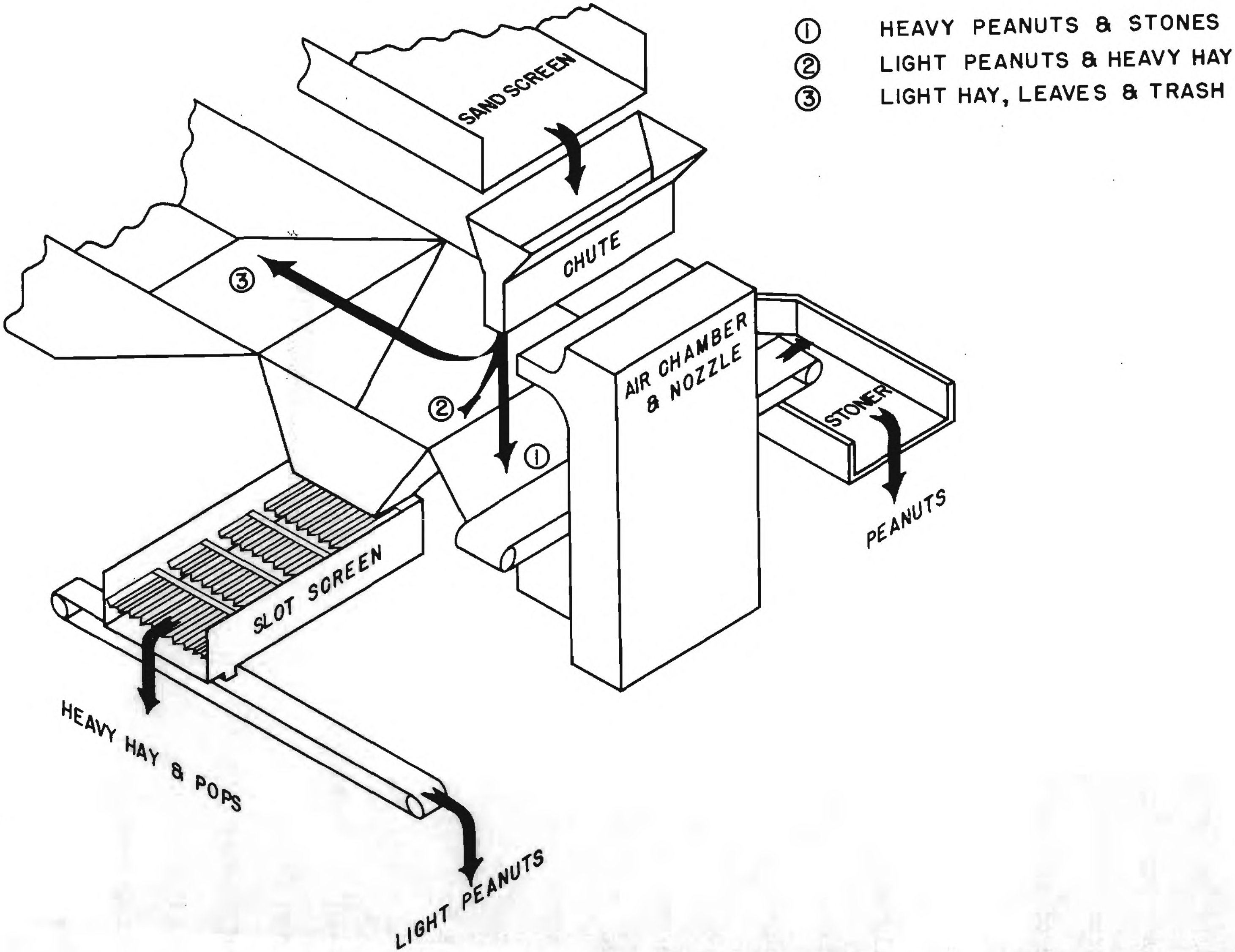

Figure 2. Schematic Diagram of Experimental Precleaner Using Air Blast and Slot Screen and Stoner at the Red Diamond Mills.

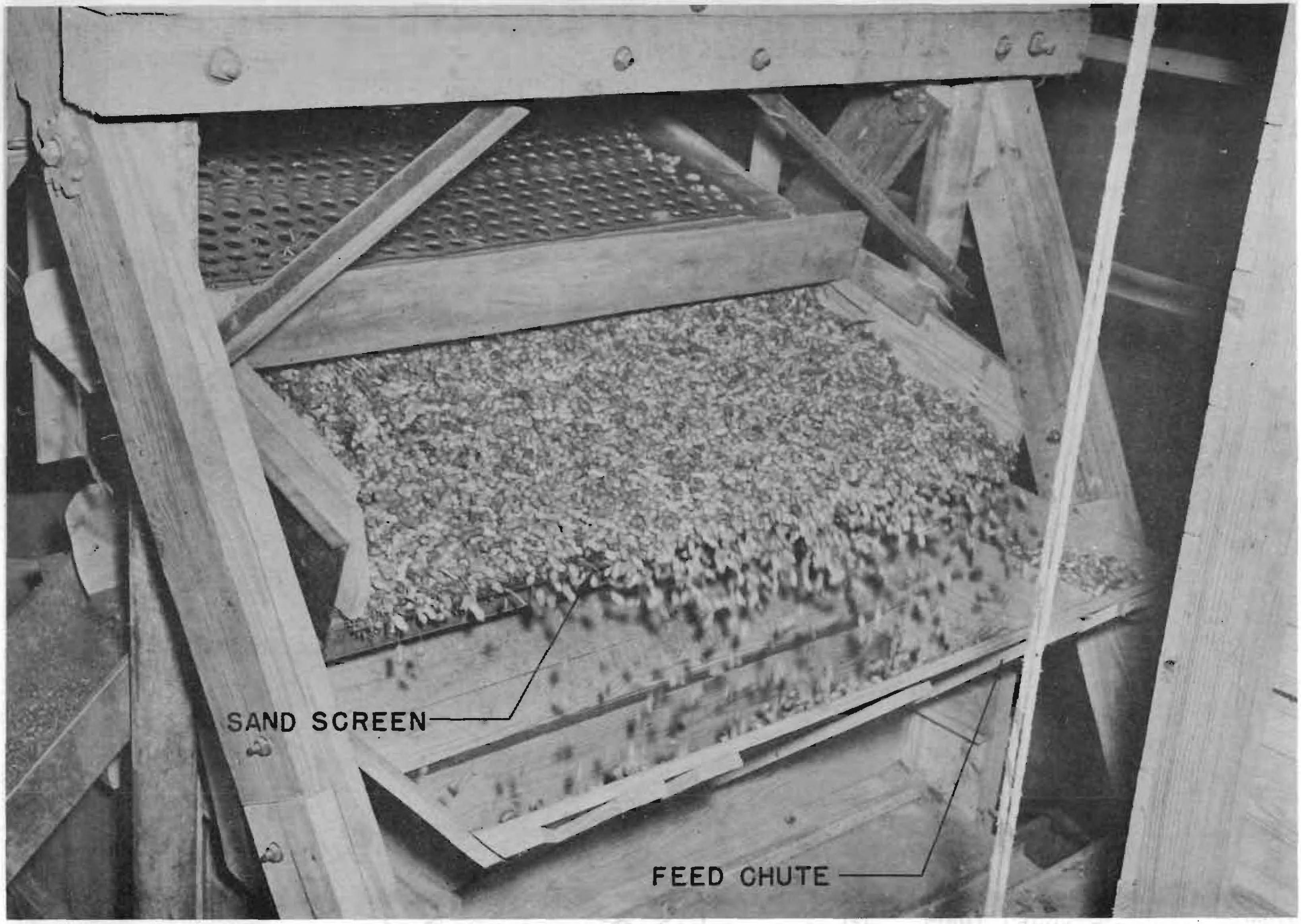

Figure 3. Peanuts Feeding from Sand Screen into Feed Chute.

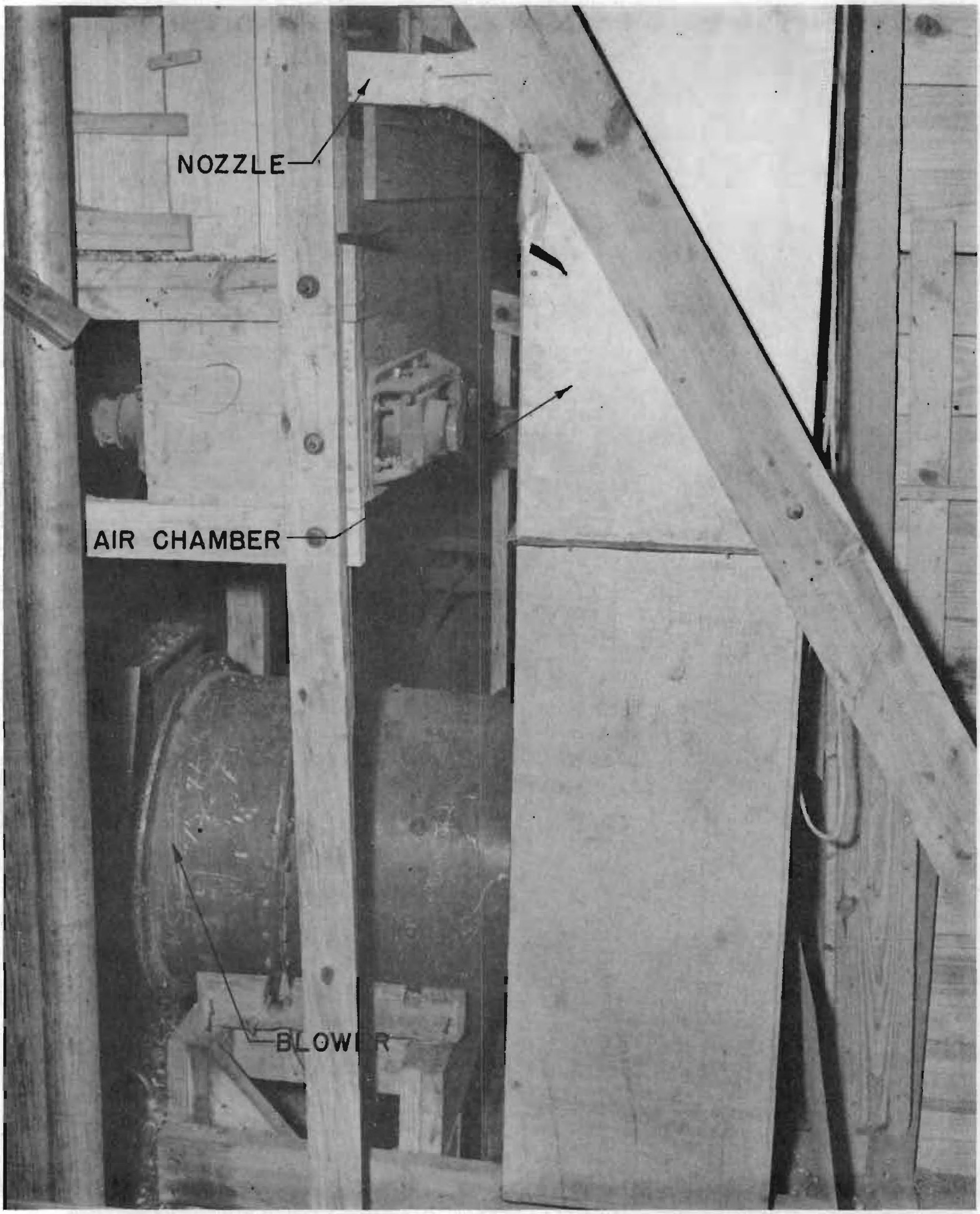

Figure 4. Blower, Air Chamber, and Nozzle.

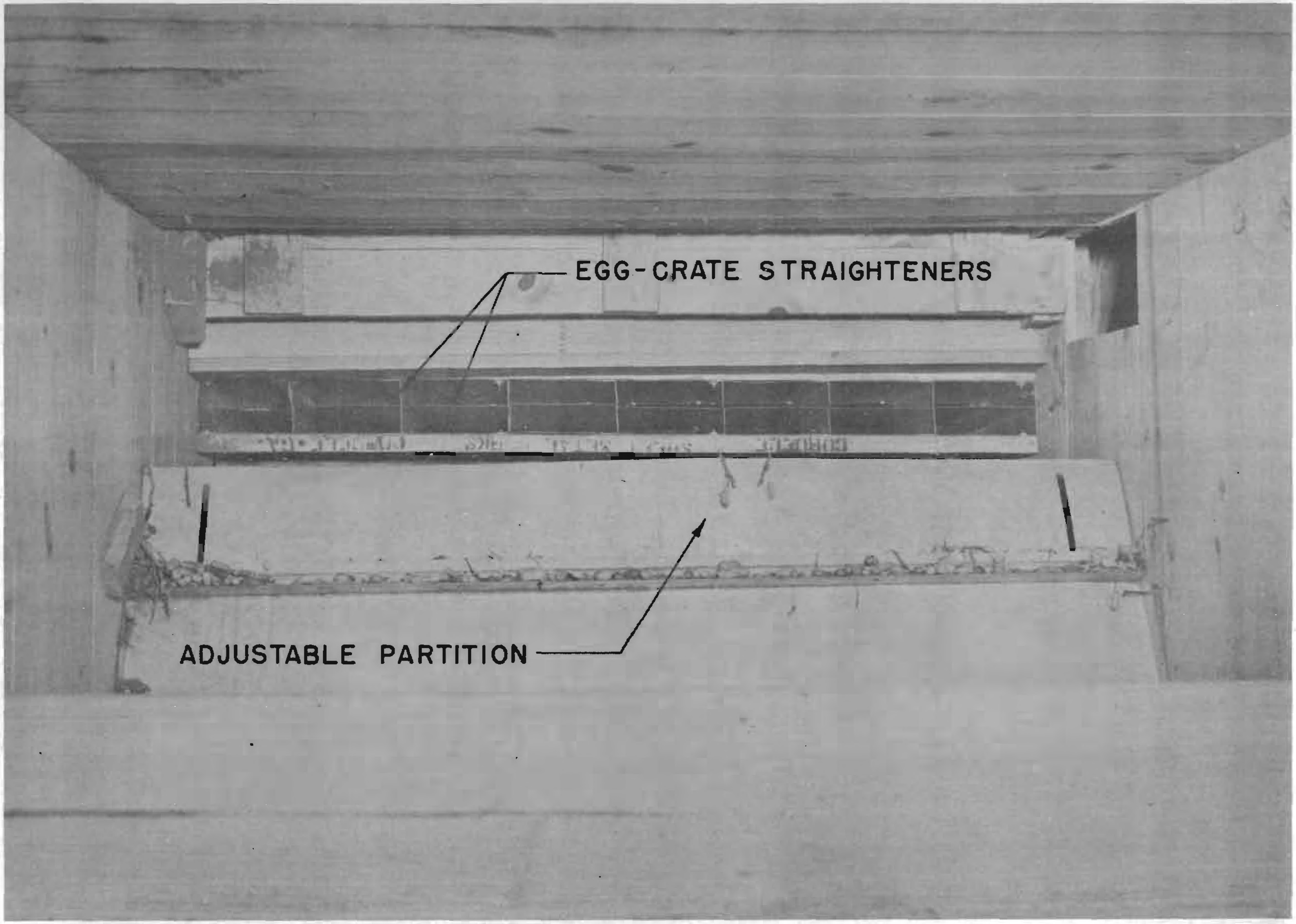

Figure 5. Front View of Nozzle.

Figure 6. Sutton, Steele & Steele Stoner.

Figure 7. Corrugated Slot Screen.

Leaves, light sticks, hulls, and light trash are blown into section three. The air is exhausted from the rear of the building.

2. Machinery Size and Costs

a. Air-Blast Cleaner. The size of each component of the pilot air-blast cleaner is given in Table I together with an estimate of the cost of the equipment, including its installation cost.

TABLE I

SIZE AND COST OF COMPONENTS FOR AIR-BLAST CLEANER

Item	Width (Inches)	Length (Inches)	Depth (Inches)	Cost
Feed Chute	40	3	15	$ 10.00
Air Chamber	44	20	72	70.00
Nozzle	44	10	3	40.00
Receiving Chamber	44	144	—	125.00
Axial Flow Blower (5 HP, 6000 CFM, 3 in. H_2O)	—	—	—	325.00
		Total		$570.00

b. Corrugated Slot Screen. The pilot-model slot screen, shown in Figure 7, was made just as the laboratory model described in last year's report, except for size and the addition of a blower below the screen. This blower forces air through the slots at a velocity of 500-700 feet per minute. Peanuts fall through the slots in spite of the upward moving air stream, but hulls, pops and the shorter sticks have a tendency to float over the slots.

Both the dimensions and the cost (installed) of each major component of the slot screen are given in Table II.

TABLE II

SIZE AND COST OF COMPONENTS FOR V-CORRUGATED SLOT SCREEN

Item	Width (Inches)	Length (Inches)	Depth (Inches)	Cost
Slot Screen	36	60	10	$150.00
No. 6 Shaler Shaker	--	--	--	90.00
1/2 HP Shaker Motor	--	--	--	40.00
1400 CFM Blower	--	--	--	35.00
1/2 HP Blower Motor	--	--	--	40.00
Air Chamber	36	10	36	25.00
			Total	$480.00

The total cost (in place) for the air blast cleaner and slot screen was $1,050. This does not include the cost of the supplementary machinery or conveyors.

3. Experimental Work

The loads which were processed have been divided into three general classes in order to facilitate analysis of the data. The classifications selected are: (1) high foreign material content (above 9 per cent); (2) medium foreign material content (less than 9 per cent); and (3) low foreign material content (loads which had already been pre-cleaned).

a. Loads with High Foreign Material Content. The data tabulated in Table III were collected from a series of runs with loads having a high foreign material content. Each load was sampled for the determination of the inspectors' grade before cleaning. Additional samples were taken from the cleaned peanuts by inserting a bucket in the

TABLE III

HIGH FOREIGN MATERIAL CONTENT LOADS

Load No.	Type of Peanut	Inspectors' Grade (%)	Foreign Material In Load* Orig. (%)	Foreign Material In Load* Final (%)	Sticks Orig. (%)	Sticks Final (%)	Stones Orig. (%)	Stones Final (%)	Dirt Orig. (%)	Dirt Final (%)	Hulls & Leaves Orig. (%)	Hulls & Leaves Final (%)
1	SP	14.0	9.3	1.6	3.5	1.22	3.0	0.03	1.6	0.20	1.20	0.15
2	SP	18.0	10.2	1.6	2.8	1.45	4.2	0.03	2.1	0.04	1.10	0.08
3	SP	4.0	9.4	1.8	4.0	1.49	1.4	0.00	2.6	0.27	1.40	0.04
4	SP	27.8	30.7	4.2	2.9	0.81	11.0	1.40	13.0	1.73	3.80	0.26
5	RU	16.0	12.9	1.2	5.1	0.85	4.9	0.16	1.6	0.11	1.30	0.08
6	SP	11.0	13.0	2.6	3.6	1.08	2.2	0.08	4.7	1.28	2.50	0.16
7	SP	23.0	35.4	5.5	25.0	4.62	3.5	0.05	2.6	0.78	1.80	0.05
8	RU	29.0	20.9	4.2	9.1	3.00	9.5	1.05	1.3	0.10	1.00	0.05
	Average		17.73	2.84								

*Original=amount removed by process plus amount remaining in cleaned load as determined by bucket sample given as per cent of in-weight; final, as per cent of out-weight.

discharge stream at timed intervals. The true initial foreign material content was assumed to be the sum of the foreign material found in the discharge and the material removed during cleaning.

An analysis of the data of Table III reveals that the arithmetical average of the foreign material content of incoming loads was 17.73 per cent and the average of the cleaned loads was 2.84 per cent.

The primary purpose of this report is to cover the experimental machinery in question. The data collected in these tests, however, revealed discrepancies between the inspectors' grade and the actual foreign material content of loads. This deviation from true grade is attributed specifically to the existing sampling procedure and equipment and to the high foreign material content of the loads. Table IV shows the grade deviation to be an average of ± 6.2 per cent. A plus sign shows the inspectors' grade higher than the actual foreign material content and a minus sign shows the actual foreign material content greater than the inspectors' grade. This situation is unhealthy from the standpoint of good business practice, since a possible ± 6 per cent variation resolves itself into a gamble for the parties concerned. The cost records on test loads processed in this study indicated that the sellers saved an average of $16.70 per ton by having the peanuts cleaned prior to sale.

The foreign material breakdown reveals that a prediction of expected deviation can be made. In general, when the proportion of rocks in the foreign material make-up is high, the seller will suffer a grade loss; on the other hand, when the stick percentage is high, the buyer suffers a grade loss. This does not hold true in Load No. 4, but this variation is attributed to a high proportion of dirt in the foreign material.

TABLE IV

DEVIATION FROM ACTUAL GRADE
(HIGH FOREIGN MATERIAL CONTENT LOADS)

Load No.	Foreign Material in Total Load: Inspectors' Grade (%)	Foreign Material in Total Load: Actual FM** Found in Load (%)	Deviation (% FM**)	Foreign Material Breakdown* — Sticks, Dirt, Trash: Per Cent of Total Load	Foreign Material Breakdown* — Sticks, Dirt, Trash: Per Cent of Total FM**	Foreign Material Breakdown* — Stones: Per Cent of Total Load	Foreign Material Breakdown* — Stones: Per Cent of Total FM**
1	14.0	9.3	+5.7	6.3	68.0	3.0	32.0
2	18.0	10.2	+7.8	6.0	59.0	4.2	41.0
3	4.0	9.4	-5.4	8.0	85.0	1.4	15.0
4	27.8	30.7	-2.9	19.7	64.0	11.0	36.0
5	16.0	12.9	+3.1	8.0	62.0	4.9	38.0
6	11.0	13.0	-2.0	10.8	83.0	2.2	17.0
7	23.0	35.4	-12.4	29.4	90.0	3.5	10.0
8	29.0	20.9	+8.1	11.4	55.0	9.5	45.0
Average Deviation			±6.2				

*The foreign material breakdown shows the per cent of sticks, dirt and trash in the total load and the per cent of the total foreign material which is in the load. The rock content is treated in the same manner.

**FM denotes foreign material.

b. Loads with Medium Foreign Material Content. Loads containing an average of 7.4 per cent foreign material were processed through the cleaner and cleaned to an average of 1.13 per cent foreign material at high feed rates. The relevant information is shown in Table V.

c. Loads with Low Foreign Material Content. Loads which had previously been cleaned by a farmers' stock precleaner were processed through the air-blast cleaner; the results are shown in Table VI. The average final foreign material content was 0.36 per cent.

d. Effect of Air-Blast Cleaner on Sound Mature Kernel Content and Damage. One characteristic of the air blast is that it separates the light and heavy peanuts. Although extensive data were not taken regarding the effect of this separation on damage and sound mature kernel content, in those which were collected it was found that the sound mature kernel content in the heavy portion was raised 1 to 4 per cent and damage was reduced 0.5 to 3 per cent. The sound mature kernel content was raised in all cases, but the change in damage was not consistent. This condition may be dependent on the type of damage. It is believed that peanuts damaged in the ground by forces that deter the growth of the peanut or cause rot can be separated from the undamaged peanuts by the air-blast cleaner. The results obtained are shown in Table VII.

4. The Scope of the Air-Blast Cleaner

The data presented in this report indicate that a large volume of peanuts can be cleaned efficiently at high speed. No pilot model tests have been conducted at lower capacities, although the laboratory tests show that cleaning efficiency increases with decrease in capacity. It was felt that the results obtained at the higher capacities would be more significant as a rating for the equipment.

TABLE V

MEDIUM FOREIGN MATERIAL CONTENT LOADS

Load No.	Type	Original FM** Content (%)	FM** After Cleaning: Heavy Portion (%)	FM** After Cleaning: Light Portion (%)	FM** After Cleaning: Total (%)	Load Division*: Heavy (%)	Load Division*: Light (%)	Feed Rate (Tons/Hr.)
9	SP	6.8	0.45	0.56	1.01	95	5	12
10	SP	8.3	0.73	0.88	1.61	93	7	12
11	RU	8.5	1.02	0.48	1.50	92	8	8
12	SP	6.0	0.12	0.28	0.40	95	5	10
Average		7.4	0.77		1.13			

*This column indicates the percentage of the total load divided into the heavy and light portions.
**FM denotes foreign material.

TABLE VI

LOW FOREIGN MATERIAL CONTENT LOADS

Load No.	Type	Original FM* Content (%)	FM* After Cleaning: Heavy Portion (%)	FM* After Cleaning: Light Portion (%)	FM* After Cleaning: Total (%)	Load Division: Heavy (%)	Load Division: Light (%)	Feed Rate (Tons/Hr.)
13	RU	1.5	.17	.33	.50	88	12	10
14	RU	1.5	.24	.23	.47	85	15	11
15	SP	1.1	.00	.12	.12	88	12	10
Average		1.36	.13	.68	.36			

*FM denotes foreign material

TABLE VII

EFFECTS ON DAMAGE AND SOUND MATURE KERNEL CONTENT

Load No.	Before Cleaning		After Cleaning					
			Heavy Portion		Light Portion		Load Division	
	SMK*	Damage	SMK* (%)	Damage (%)	SMK* (%)	Damage (%)	Heavy (%)	Light (%)
16	72	2	75	1	--	--	92	8
17	68	2	69	1	--	--	90	10
18	66	4	74	1	59	3.50	85	15
19	72	3	75	2.5	49	2.50	93	7
20	75	2.5	77.8	1.5	67.5	3.25	82	18

*SMK denotes sound mature kernels.

An analysis of the performance of the air-blast cleaner indicates that:

a. The peanuts are separated into a heavy and a light portion. The ratio of the two portions can be controlled readily.

(1) The heavy portion will contain a minimum of foreign material and show a rise in sound mature kernel content and possibly a decrease in damage.

(2) The light portion will contain some small sticks and have a low sound mature kernel content and possibly a high damage content; it will contain most of the foreign material remaining in the total load.

b. Peanuts are cleaned efficiently at high speed, regardless of their initial foreign material content.

c. A small cleaner of the same type could be adapted in a farmer's combine to achieve better cleaning while picking and threshing.

d. The cleaner could be set up at the farm as an individual unit to process peanuts prior to sale. Such equipment would allow the farmer to up-grade his crop and, by splitting the heavy and light portions on a 90-10 per cent basis, would result in a better price for the 90 per cent portion than for the total load without any cleaning and up-grading. The ten per cent portion could be sold as oil stock or used as feed.

e. The cleaner could be used at the shelling plant as a pre-cleaner prior to purchase.

f. It could be used as a prime precleaner in shelling plants.

g. It could be used as a supplemental cleaner in shelling plants.

In addition to the removal of foreign material, another valuable use of this machine is the separation of the light and heavy nuts, routing the low-grade peanuts directly to the No. 2 shellers and thus decreasing the load on the No. 1 shellers and the following separator as well as effecting a potential segregation of damaged peanuts. In addition, the segregation of damaged peanuts should result in a saving in the picking operation. A test installation of this type is now being made.

C. Experimental Conclusions

The performance of the pilot model air-blast cleaner compared favorably with that of the laboratory model. Capacities of 4.3 tons per hour per foot of width were attained, using 1.75 hp per foot of width. A total of 6 hp was required for the experimental pilot model.

Cost for the 3.5 foot machine was $300 per foot of width or $1050 total cost.

Foreign material removal was found to be somewhat dependent on the amount initially present. The following figures indicate approximately the results which can be anticipated:

Foreign Material Content of Load (Per Cent)	Maximum After Cleaning (Per Cent)
30-40	6.5
20-29	5.0
10-19	3.5
5-9	2.0
1-4	1.0

These figures represent the foreign material remaining in the total cleaned load. Actually the foreign material in the major portion will be considerably less than indicated by these figures.

The machine does not require an attendant after it has been put into operation.

The machine appears to have at least five potential uses:

1. For the Farmer

   a. As an integral adjunct to his combine and threshing machine.

   b. As a separate unit to clean and up-grade his product prior to sale; and

2. For the Shelling Plant

   a. As a precleaner prior to grading;

   b. As a primary precleaner prior to processing; and

   c. As a supplemental cleaner after preliminary cleaning by methods now employed.

D. Recommendations

An installation of the air-blast cleaner as a supplementary precleaner in a shelling plant should be tested and evaluated. Use of this cleaner for all peanuts prior to purchase should be given serious consideration by members of the industry, as it offers a solution to the problem of accurate grading.

The air-blast cleaner or its components should be incorporated into the design of combines or, alternatively, into a small, separate, low-cost machine for farm use.

III. ROTARY DISC SCREEN

A. Introduction

In the area around Statesboro, Georgia, where the Virginia-type peanut is grown, a certain portion of the crop contains the large roasting-type peanut. There is a considerable economic advantage in separating the larger peanuts from the smaller ones, because of the premium price obtainable for jumbo nuts.

Although the rotary disc screen was originally designed to separate small stones from farmers' stock peanuts, it was early found to have useful applications to the sizing of peanuts in the shell (as described in last year's report). In order to test this application under plant conditions, a pilot-scale model of the rotary disc screen was built and installed at the East Georgia Peanut Company in Statesboro. The cost of the material and labor was defrayed by the Company, and the Engineering Experiment Station furnished the engineering supervision. Initial tests, made in the late spring, indicated that the machine is capable of effective sizing without clogging in operation.

Laboratory studies of the rotary disc screen have suggested two other useful applications: (1) for the removal of sand from unshelled peanuts, and (2) for the removal of loose kernels from farmers' stock peanuts prior to shelling.

B. Experimental Work and Discussion

1. Machinery Size

Four gangs of discs were used in the construction of the rotary disc screen shown in Figure 8. The sets of discs were placed on an angle-iron framework which sloped at a 30-degree angle. A 1-hp ratio-motor rotated the discs at 48 rpm by means of a roller chain drive. Removable partitions in the main chute caught material coming through each set of discs. Figure 9 is a front view of the sizer. The spacers were plywood, 7-1/4 inches in diameter, and planed to the desired thickness. The discs were made of 20-gauge galvanized sheet iron 13-7/8 and

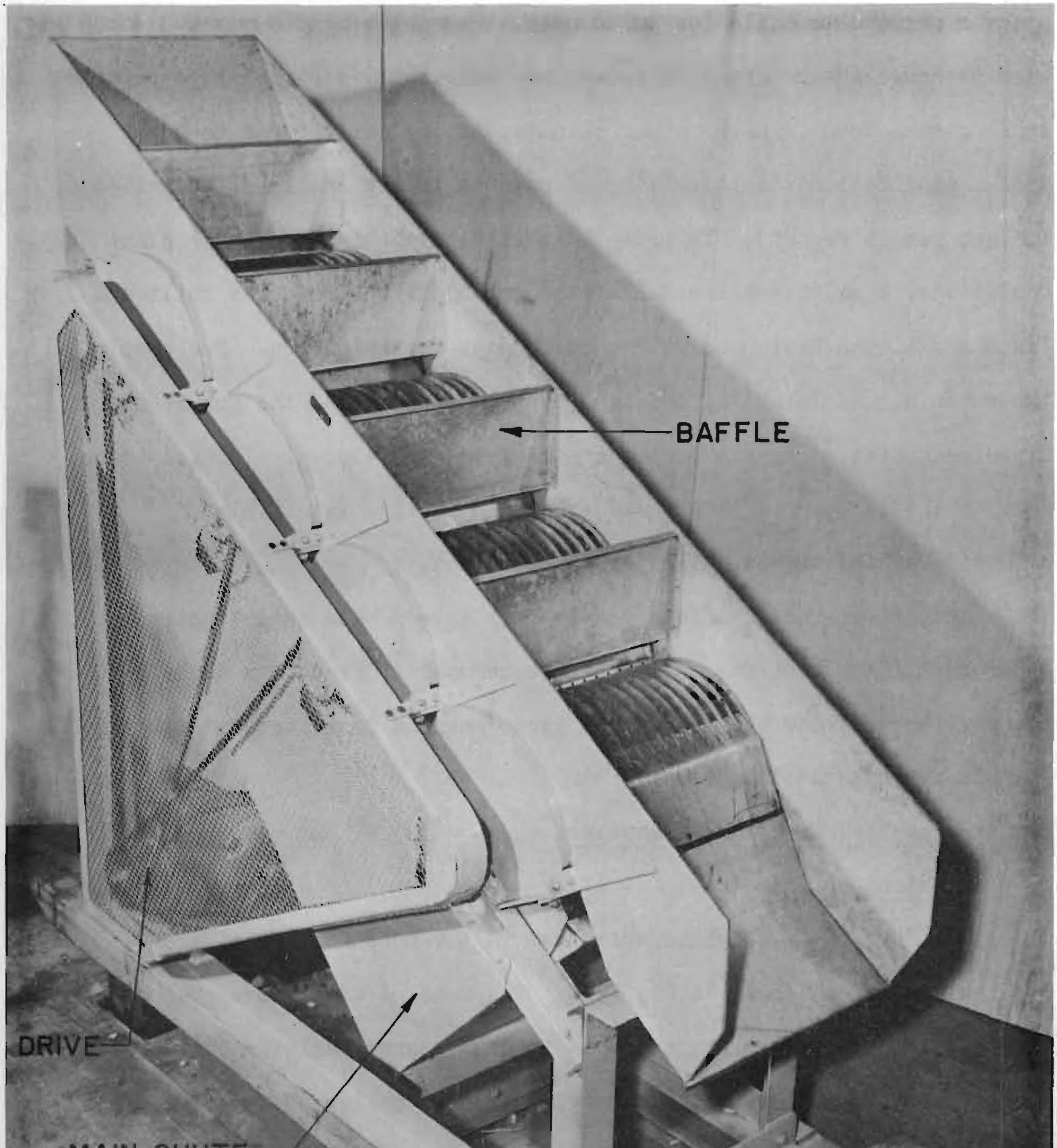

Figure 8. Side View Experimental Rotary Disc Screen.

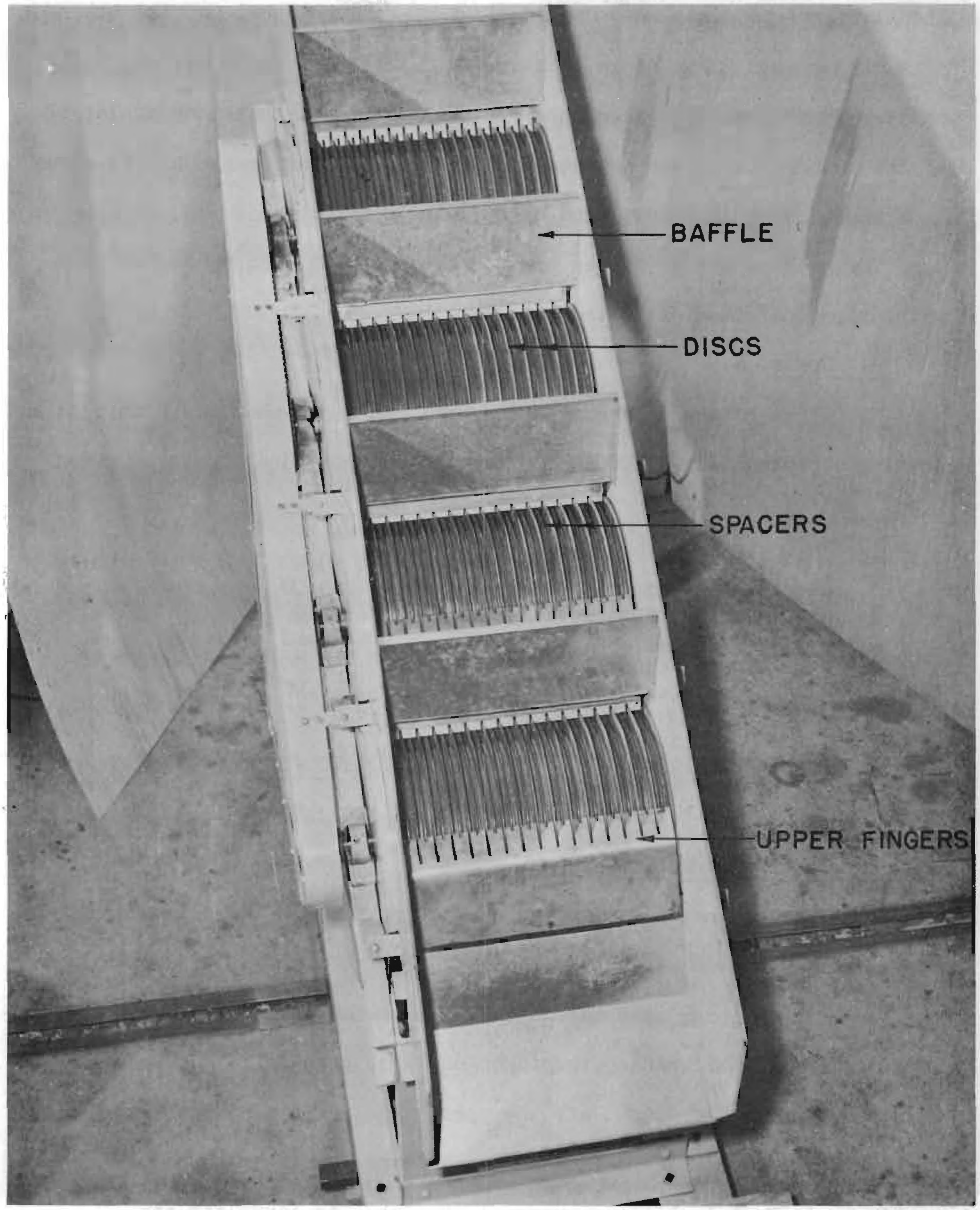

Figure 9. Experimental Rotary Disc Screen.

14-7/8 inches in diameter, and the fingers were made of 1/4-inch brass. The first set of discs was spaced 30/64 of an inch apart and the other sets were spaced 32/64 of an inch apart. Every other disc was one inch smaller in diameter in order to align the peanuts so that they could, if of the proper size, drop between the discs. The stationary baffles shown in Figure 9 were later replaced by swinging baffles.

The machine was 60 inches high, 24 inches wide, and 65 inches long, with an inside width of 18 inches.

2. Costs

This rotary disc screen was built on a job-shop basis at a total cost of approximately $1,000. A breakdown of individual costs is given below.

Plywood	$ 53.00
Ratio-motor and controls	200.00
Chains, sprockets, bearings	75.00
20 ga. galvanized iron	50.00
Angle, channel, shafts	50.00
Nuts, bolts, etc.	10.00
Brass	40.00
Miscellaneous	25.00
Labor	470.91
Total	$973.91

3. Tests and Discussion

Various batches of peanuts were run through the pilot machine. Table VIII shows the percentages falling through each set of discs and the percentages going over the discs. The variation in the amounts going over was due to different percentages of large peanuts in the original lots processed. Also shown are the percentages of the "amount-over" portion which rode a 34/64-inch screen and the count per pound of this portion. A 32/64-inch screen was not available to correlate the

TABLE VIII

PERCENTAGE OF PEANUTS RIDING AND PASSING ROTARY DISC SCREEN

Load No.	Percentage in Each Section					Portion Over Discs	
	Sect. I (%)	Sect. II (%)	Sect. III (%)	Sect. IV (%)	Over (%)	Percentage Which Rode 3" x 34/64" Screen (%)	Count/Lb.
1	22.8	12.7	3.9	1.5	59.1	85	224
2	37.4	21.4	8.2	3.2	29.8	88	216
3	18.4	10.0	2.8	1.6	67.2	92	208
4	16.2	7.8	3.2	0.8	71.9	85	220

relationship between screen size and disc spacing at the time the tests were run. Incoming feed rates as high as two tons per hour per foot of width were obtained. It was found that the rotary disc screen operated best when the peanuts had been cleaned prior to processing.

During the latter part of the year, evidence of mechanical damage to the shells was noted. Tests showed this damage to run from one to three per cent. Some of the damage was attributed to prior handling before processing; and some, to the machine. Since the remaining peanuts on hand were relatively dry and contained a high percentage of mechanically damaged nuts, further damage testing was postponed until the new crop came in.

Experimental runs using the laboratory model as a sand screen were made with the discs set 1/8-inch apart. Batches containing 20 per cent sand were prepared and run over the screen. All measurable quantities of sand were removed in one pass of the samples over the screen. In initial tests, the screen was clogged by loose shells which were in the batch. Therefore, a set of fingers was made and installed on the under side of the screen, after which no clogging occurred on peanuts which had not been precleaned.

In conjunction with the sized-shelling tests, a rotary disc screen was used with a disc spacing of 22/64-inch, and farmers' stock containing loose kernels was processed. In one pass across the screen, 99 per cent of the loose kernels in the batch were removed from the farmers' stock.

C. Experimental Conclusions

The rotary disc screen performs specific sizing and separation and does not clog with the product it is processing. Its capacity is about two tons per hour per foot of width. The initial cost of the screen could probably be lowered appreciably by production-line manufacturing. This machine can also be used as a sand screen and for separating loose kernels from farmers' stock peanuts. Other possible uses in the peanut shelling industry are for sizing shelled goods and as a scalping screen.

D. Recommendations

The rotary disc screen should be further tested and evaluated.

IV. VACUUM QUALITY PICKING

A. Introduction

The use of a suction system for quality picking of shelled peanuts was suggested by a member of the industry who had done some work along that line. Since his main difficulty had been designing a tip or nozzle which would pick up only the bad kernels, the Station designed a nozzle which would pick up only one kernel at a time. An experimental suction system was constructed and assigned to the Industrial Engineering Survey Group for testing and evaluation. Detailed results of this work and other picking studies will be covered in a report to be published later in the year.

B. Experimental Work and Discussion

The nozzle designed for use with a suction system is shown assembled in Figure 10 and disassembled in Figure 11. The movable pickup tube has slots cut in it, with an annular ring placed one inch from the end. This tube fits into the main tube which has, at one end, a retainer ring allowing free sliding movement of the pickup tube until stopped by contact with the annular ring. The spring is then placed over the pickup tube and inside the main tube. The hose connector fits over the pickup

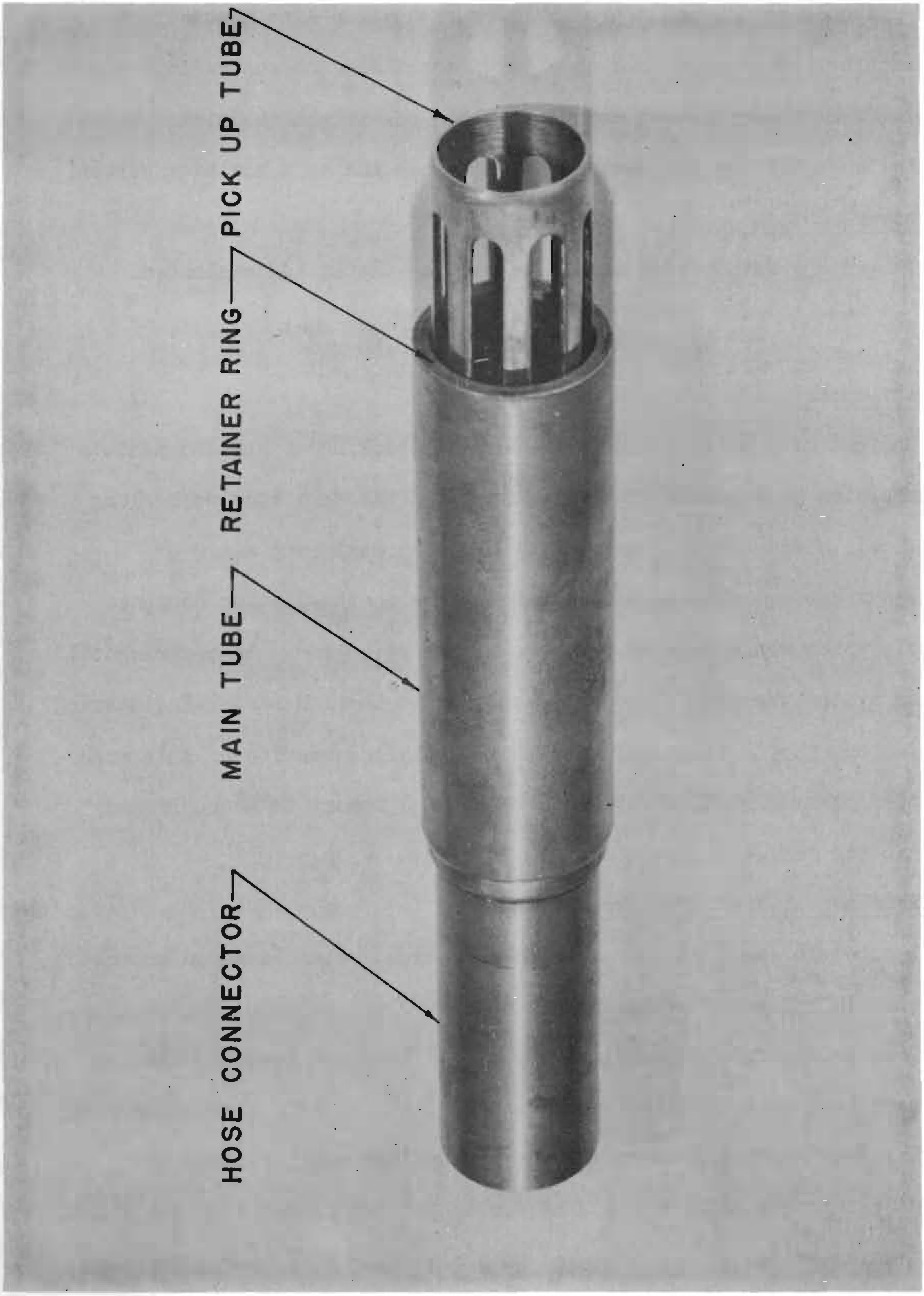

Figure 10. Suction Nozzle Assembly.

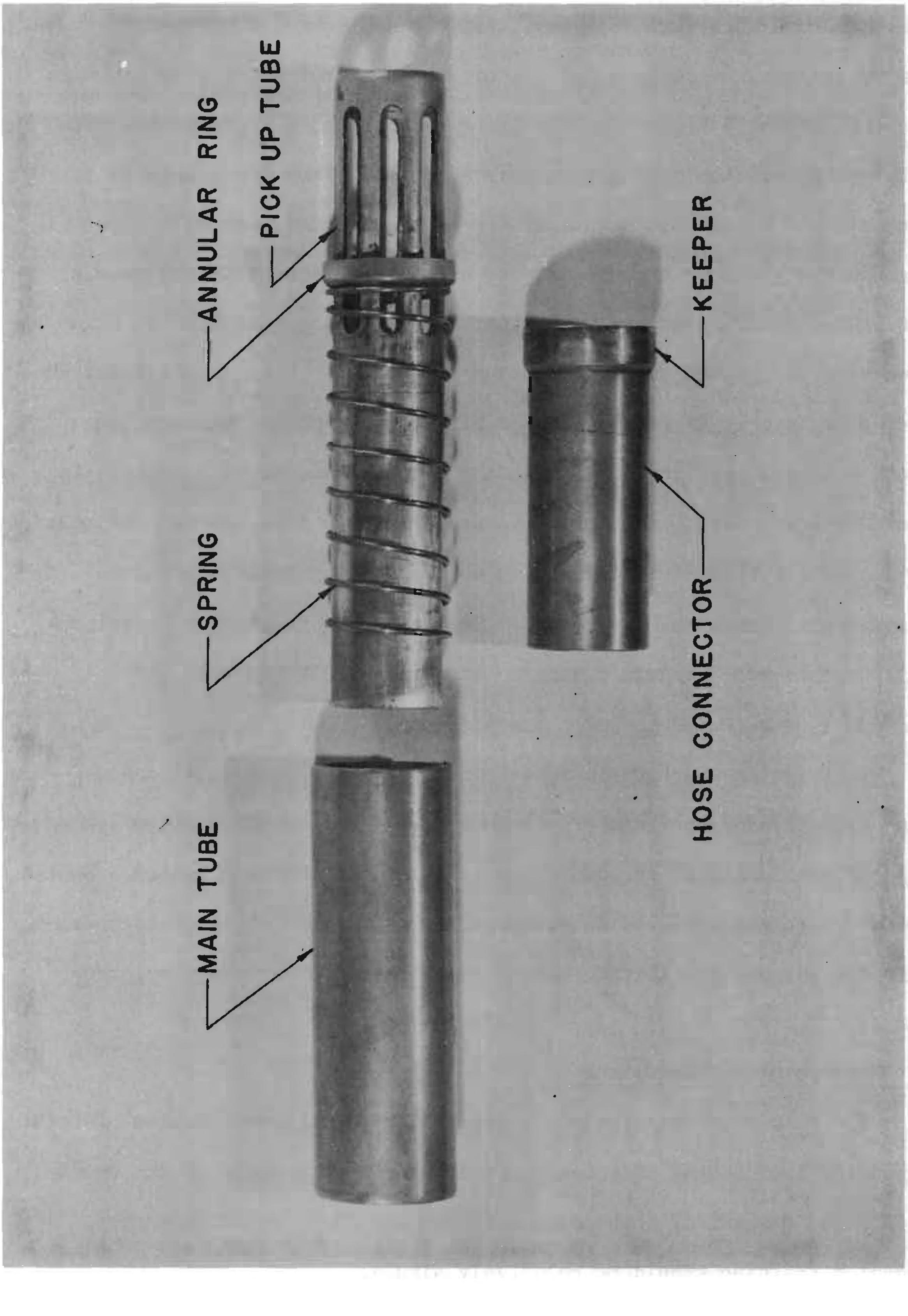

Figure 11. Suction Nozzle Disassembled.

tube with a sliding fit and, at the same time, the keeper fits inside the main tube with a light press fit. The spring which has been compressed by the keeper keeps the pickup tube protruding from the main tube, as shown in Figure 10. In using the nozzle, one grasps the main tube and lowers the pickup tube over a peanut. When the nozzle is connected to a suitable vacuum system by an air hose, air will flow through the slots in the pickup tube and have no effect on the peanut. A slight downward pressure on the nozzle causes the main tube to slide down over the pickup tube compressing the spring. When this occurs, the open slot area is decreased and the air velocity moving through the slots increases sufficiently to lift the peanut and carry it away. As the nozzle is raised, the spring keeps the pickup tube against the belt until the air velocity decreases so that adjoining kernels are not disturbed as the nozzle is lifted. The source of vacuum for experimental purposes was a vacuum cleaner. An airtight glass jar in the suction line was used to catch the pickouts.

This system was used in tests conducted with one nozzle versus conventional hand picking. Preliminary results show the suction system capable of picking 17 per cent more peanuts than the hand method. Some operator training will be required before using this system. As operators become more proficient, better results than those reported here can be expected.

C. Experimental Conclusions

The vacuum system of quality picking shows definite promise of both improving the picking efficiency and decreasing the costs of the operation. The mechanical components required are cheap in initial cost. Operator training should be relatively simple.

D. Recommendations

A pilot vacuum-suction system should be installed in the field to permit testing and evaluation under shelling plant conditions.

V. AUTOMATIC ELECTRONIC QUALITY PICKER

The use of mechanical quality pickers in the peanut industry is not new. After the existing machinery was examined, however, it was felt that a simpler machine could be designed.

The design of such a machine includes some complex problems. A method for rapid handling of the product, an electrical system to differentiate between good and bad kernels, and a reject mechanism are the major components of an automatic picking machine. Preliminary design work on these components has been conducted and some laboratory models have been constructed. Work is now under way to assemble the components into a unit for final testing. Results to date indicate that the preliminary design is workable and that a low-cost machine can be built. Further results of this work will be included in a later report.

VI. SIZING OF FARMERS' STOCK PEANUTS PRIOR TO SHELLING

A. Introduction

It is common practice in the peanut industry to pass unsized farmers' stock peanuts through a series of shellers with successively smaller grates. The unshelled goods from the first (primary) shellers are separated from the shelled goods by screening and are then passed through the next smaller grate (secondary) shellers. The shelled goods may contain some small unshelled peanuts which pass through the screen;

these are removed by a gravity air table and are sent to the smallest grate (nub) shellers. The unshelled goods from the secondary sheller are usually recycled until they are shelled or will pass through the separating screen and go to the nub sheller.

The system outlined above uses the shellers as sizing machines. Furthermore, only about 50 to 60 per cent of the peanuts fed into the primary sheller are shelled if a 24/64-inch grate is used with Spanish peanuts. If a 22/64-inch grate is used, the shelling percentage may be 75 or 80 per cent, but the possibility of splitting the peanut kernels increases.

It was felt that sizing of peanuts before their shelling would allow use of the 24/64-inch grate in the primary shellers, thereby maintaining a low percentage of splits and, at the same time, reducing the percentage of unshelled peanuts going from the primary shellers to the separators.

In order to determine some of the effects of sizing on the shelling operation, the small experimental rotary disc screen was used to divide a batch of cleaned farmers' stock into several different sized fractions. These closely sized peanuts were then shelled with various size grates in a Medley sheller made for experimental use. The sheller was one quarter the width of the standard commercial sheller and had a rated capacity of about 500 pounds per hour.

B. Experimental Work and Discussion

The experimental runs were made with batches of from 15 to 50 pounds each. The percentage shelled, the percentage of split kernels, the feed rates and actual shelling rates were determined for each fraction. The results are given in Table IX. In all tests, the sheller speed was 250 rpm, the spacing between grates and bars was one inch, and the sheller was kept full during the test. No moisture analysis was made on the peanuts, since the tests were all made in a comparatively short period during which time the weather was warm and dry. An average moisture content of about five per cent could be assumed.

From the limited amount of data obtained, some curves were plotted in an attempt to define the relationships between the factors involved. Figure 12 is a plot of peanut diameter in 64ths of an inch versus actual shelling rate in pounds per hour. This plot indicates that the shelling rate is dependent primarily on peanut size, regardless of the grate size used to shell the peanuts.

The difference between peanut diameter and grate size appears to be a factor in determining the percentage shelled and percentage of kernels split for any given size of peanut feed to the sheller. Figure 13 shows the approximate relationship between the percentage of peanuts shelled and unshelled peanut diameter, with parameters of differences between peanut diameter and grate size. Figure 14 shows the approximate relationship of the difference between peanut diameter and grate size to the per cent of kernels split. This relationship seems to hold regardless of peanut size. The spread between points can possibly be attributed in part to difference in moisture content of the peanuts when shelled. Curves showing the size distribution of shelled and unshelled peanuts in an unsized batch of Spanish farmers' stock are given in Figure 15.

TABLE IX

SHELLING TESTS SUMMARY

Description of Portion	A Average Size	B Grate Size	A-B Difference	Per Cent Shelled	Per Cent Split	Feed Rate	Actual Shelling Rate
+27-31*	28	24	4	85	7.5	966	829
+27-31	28	22	6	91	8.2	825	750
+25-27	26	24	2	69.8	6.73	1015	712
+25-27	26	22	4	86.6	6.27	838	727
+25-27	26	20-1/2	5-1/2	90.3	6.96	818	740
+25-27	26	19	7	97.5	12.0	713	695
+23-25	24	24	0	43.3	4.22	1370	588
+23-25	24	22	21	74	6.2	756	553
+23-25	24	20-1/2	3-1/2	89.5	5.65	673	600
+23-25	24	19	5	97.0	6.5	587	550
+23-25	24	17	7	99.6	16.7	389	388
+19-23	22	17	5	94	7.7	287	270
+19-23	22	15	7	97	16.0	232	224
Unsized	25	24	1	56.4	6.1	1120	630
Unsized	25	24	1	53.6	6.2	1210	648

*+27-31 means that this portion rode the 27/64 spaced disc screen and passed the 31/64 spaced disc screen.

A—Average size=average diameter of unshelled peanuts in 64ths of an inch.

B—Grate size=width of slots in grates in 64ths of an inch.

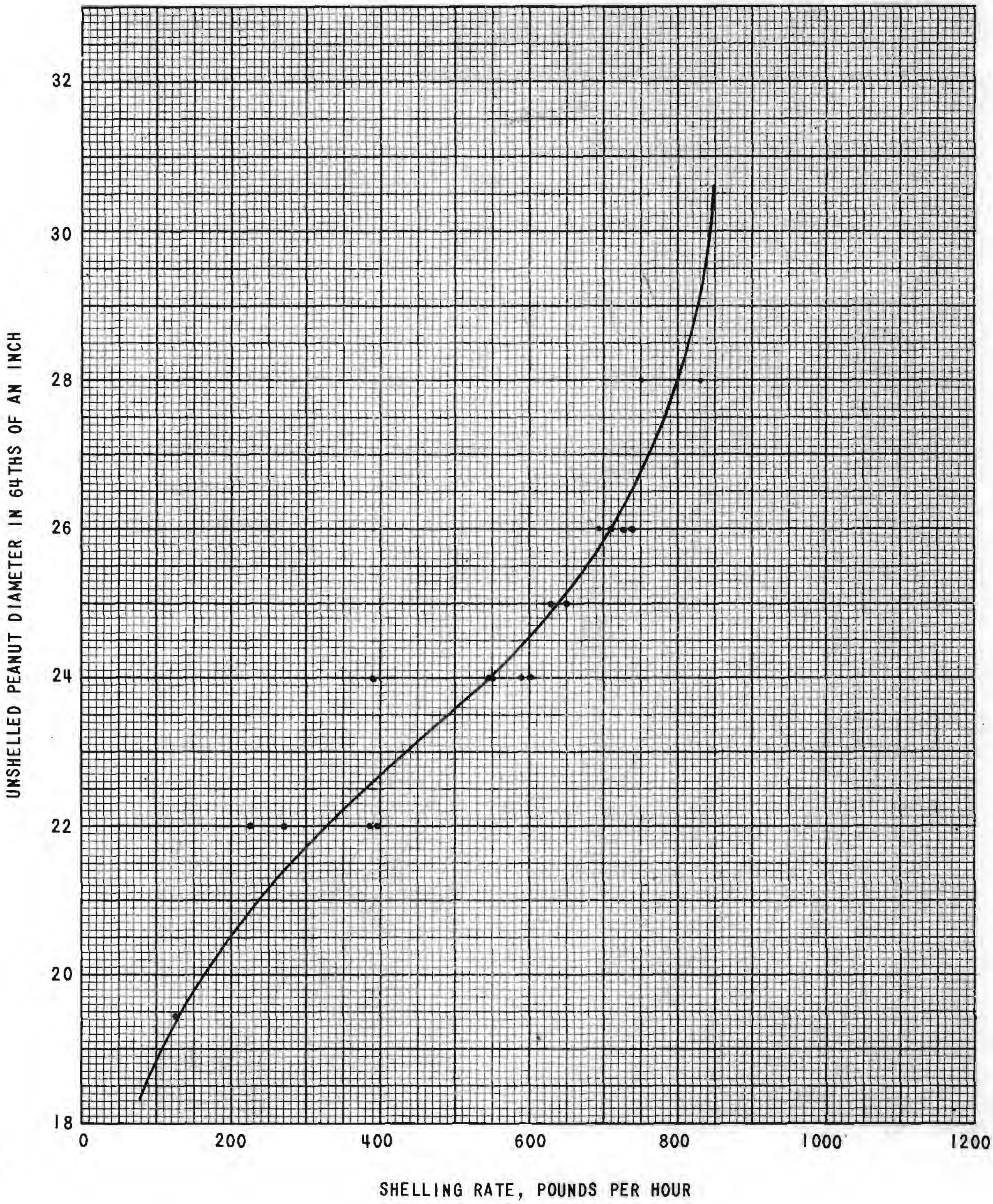

Figure 12. Shelling Rate vs. Unshelled Peanut Diameter.

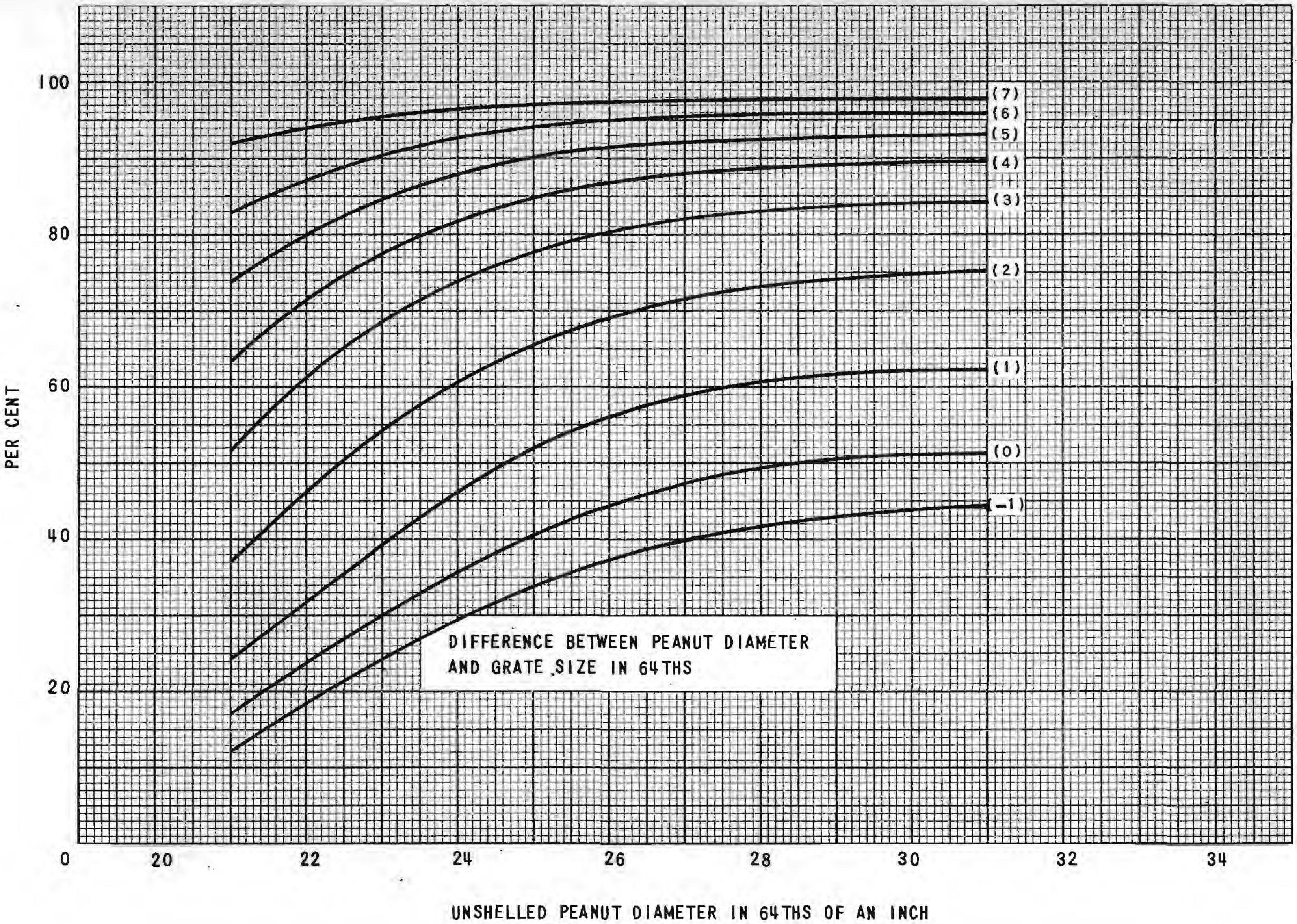

Figure 13. Per Cent of Feed Shelled as a Function of Unshelled Peanut Diameter.

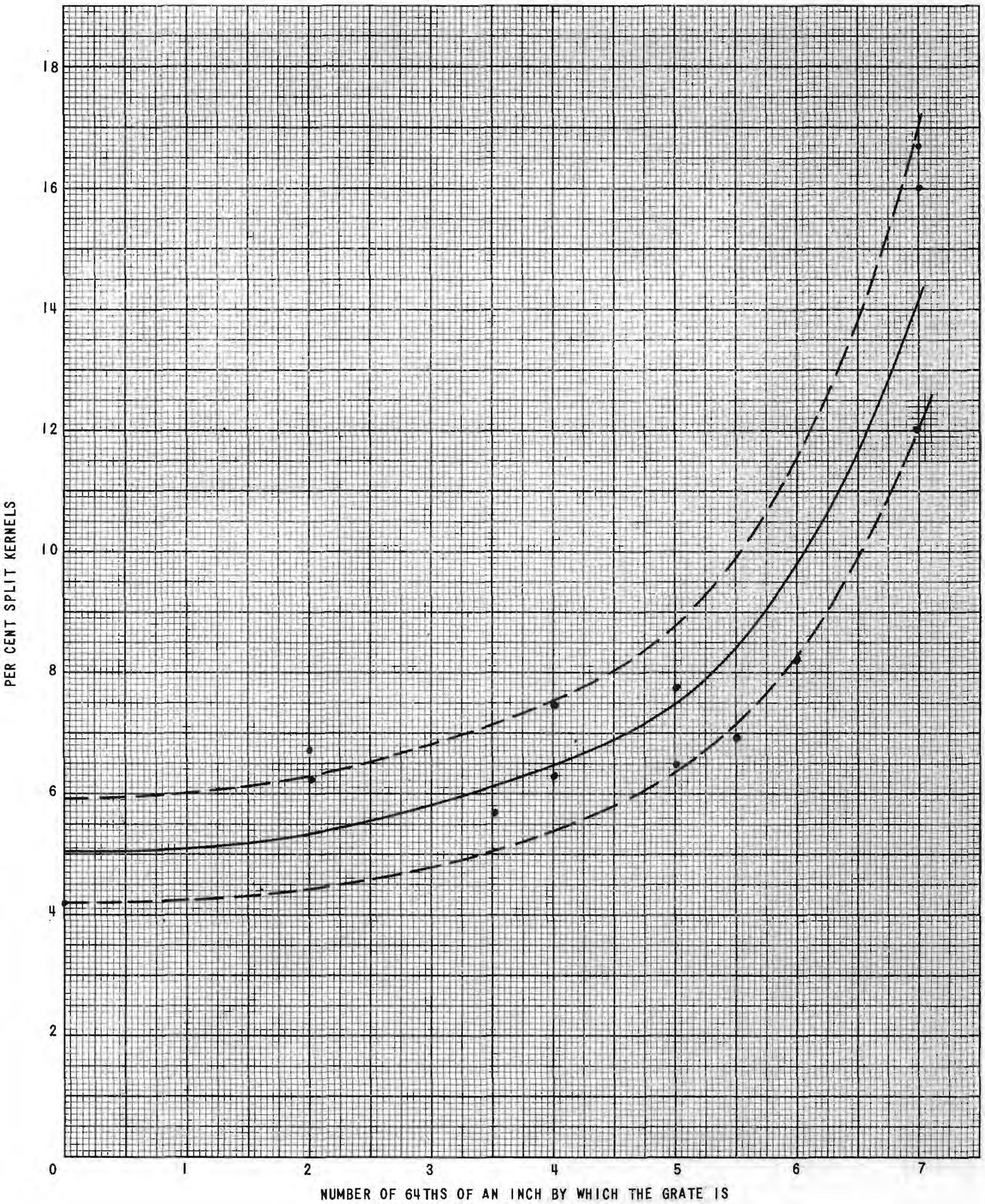

Figure 14. Difference between Peanut Diameter and Grate Size vs. Per Cent Split Kernels.

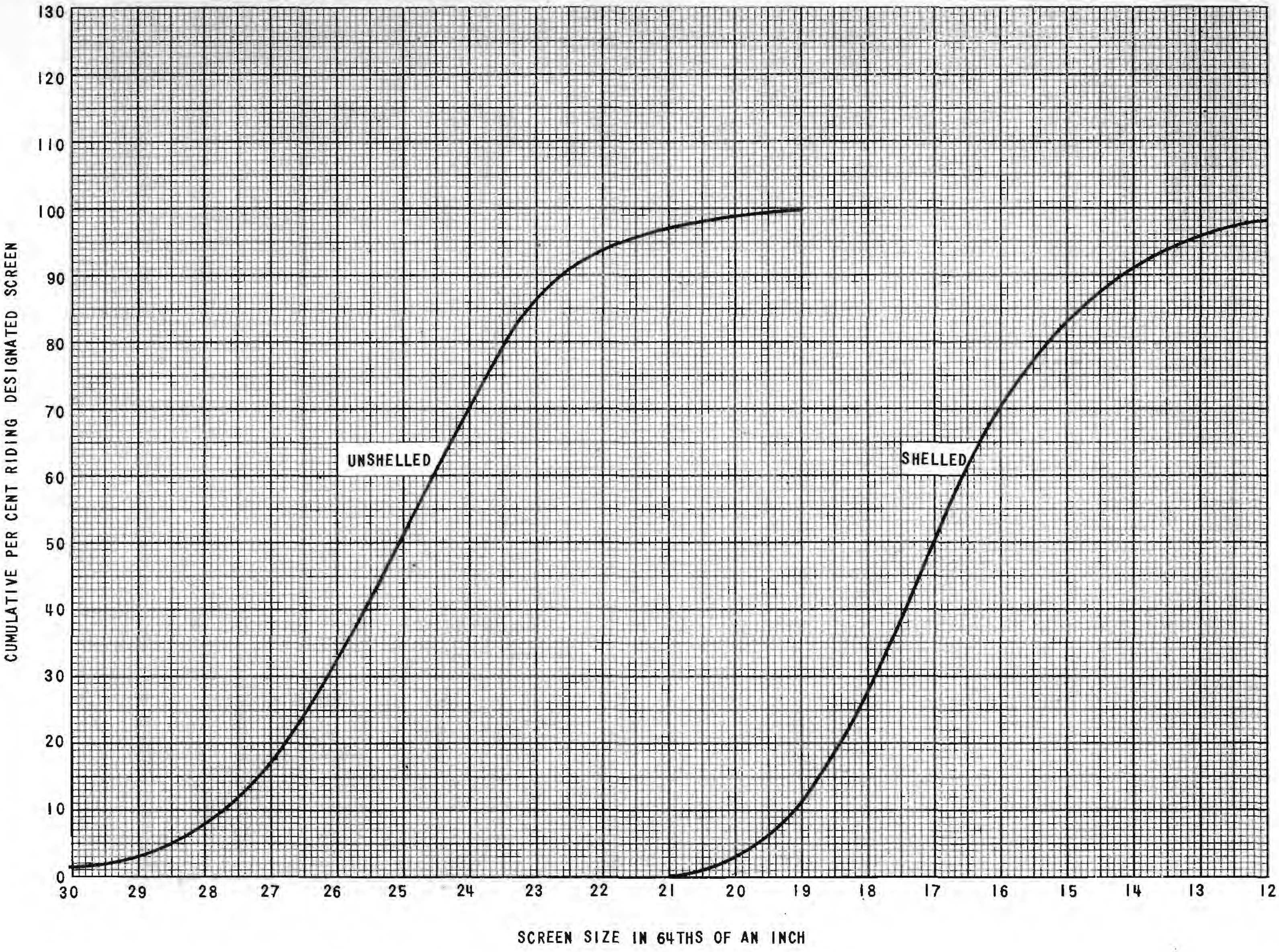

Figure 15. Size Distribution of Spanish Peanuts.

The tests which have been conducted to date were preliminary in nature, but they are believed to promise a new method of approach to problems encountered in the shelling operation.

It has been indicated that the actual shelling rate is dependent on the size of the peanut being shelled and not on the size of grate used or on the feed rate of unshelled goods to the sheller. This is contrary to first expectations, as it was felt that a low percentage shelled per pass would cause a low actual shelling rate.

The experimental results indicate that a low percentage of split kernels can be obtained by maintaining a small difference between peanut diameter and grate size. This also produces a comparatively low shelling percentage but does not affect the actual shelling rate.

Sizing a batch of peanuts into several fractions provides the shellers with portions in which the majority of the peanuts will be of approximately the same diameter. Thus, a grate size can be used which will result in a low percentage of split kernels while the shelling percentage will remain comparatively high. This method may be an aid in solving the problem of which grate size to use in the primary shellers.

Unsized peanuts run through a sheller with a 22/64-inch grate can be considered as an example. The shelling rate will be 626 pounds per hour with a 72.8 per cent shelling; however, 7.1 per cent of the kernels will be split. If some of these same unsized peanuts are run through a sheller with a 24/64-inch grate, they will have an actual shelling rate of 646 pounds per hour and only 5.7 per cent of the shelled kernels will be split; but only 55.6 per cent of the peanuts fed to the sheller will be shelled. However, if some of these same unsized peanuts are sized by use of a 25/64-inch-spaced disc screen and if the portion riding the screen is shelled with a 24/64-inch grate sheller, there will be 73.2 per cent of this portion shelled at a rate of 723 pounds per hour and only 5.9 per cent of the kernels will be split. If the unshelled peanuts are removed from the above batch and mixed with the peanuts passing through the 25/64-inch-spaced disc screen and the combined batch then shelled with a 22/64-inch grate sheller, there will be 60 per cent of this portion shelled at a rate of 540 pounds per hour and 5.8 per cent of the kernels will be split.

Combining the results of the shelling of these two sized fractions indicates that 77.4 per cent of the total original batch has been shelled at an over-all rate of 626 pounds per hour and that only 5.8 per cent of the peanuts shelled have been split. These calculations were made by use of the curves obtained from experimental data. The percentage shelled, actual shelling rate, and percentage of split kernels for the amount of each size of peanut found in the various portions, as determined from the distribution curve, were calculated and added together to obtain the results for each portion.

These theoretical calculations indicate that sizing before shelling and use of a 24/64-inch grate instead of a 22/64-inch grate in the primary shellers result in a one per cent or greater reduction is split kernels. At the same time, a high percentage of shelling is maintained in the primary shellers, eliminating an overload on the separators. The actual shelling rate also remains high.

Figure 16 is a flow sheet of the equipment involved in the following discussion of the advantages and disadvantages of sizing before shelling. The unsized peanuts are fed onto 22/64-inch-spaced discs through which loose kernels and very small unshelled peanuts pass. A large percentage of the small sticks found in peanuts which have been through a precleaner will pass through these discs. This stream may be processed over a special stick screen, such as a slot screen with narrow slots, if desired. This portion may then be sent to the separator beneath the secondary shellers where the loose kernels and nubs are removed and the unshelled peanuts riding the separator screen are sent with the recycle to the secondary shellers.

Peanuts riding the 22/64-inch-spaced disc screen are sent to a 25/64-inch-spaced disc screen. The peanuts riding over the latter are sent to the primary shellers, and the peanuts passing through are sent to the secondary shellers. Unshelled goods from each bank of shellers may be recycled until shelled. The shelled goods and nubs are removed by the separators and sent to the gravity air table, from which the nubs are sent to the nub shellers.

C. Experimental Conclusions

The rate at which peanuts are shelled is apparently independent of the grate size used, but it is greatly dependent on peanut diameter, since the larger peanuts shell at a more rapid rate than the smaller peanuts. Shelling percentage is a function of peanut diameter and the difference between peanut diameter and grate size. The percentage of kernels split is a function of the difference between peanut diameter and grate size--the larger the difference, the higher the percentage of splits.

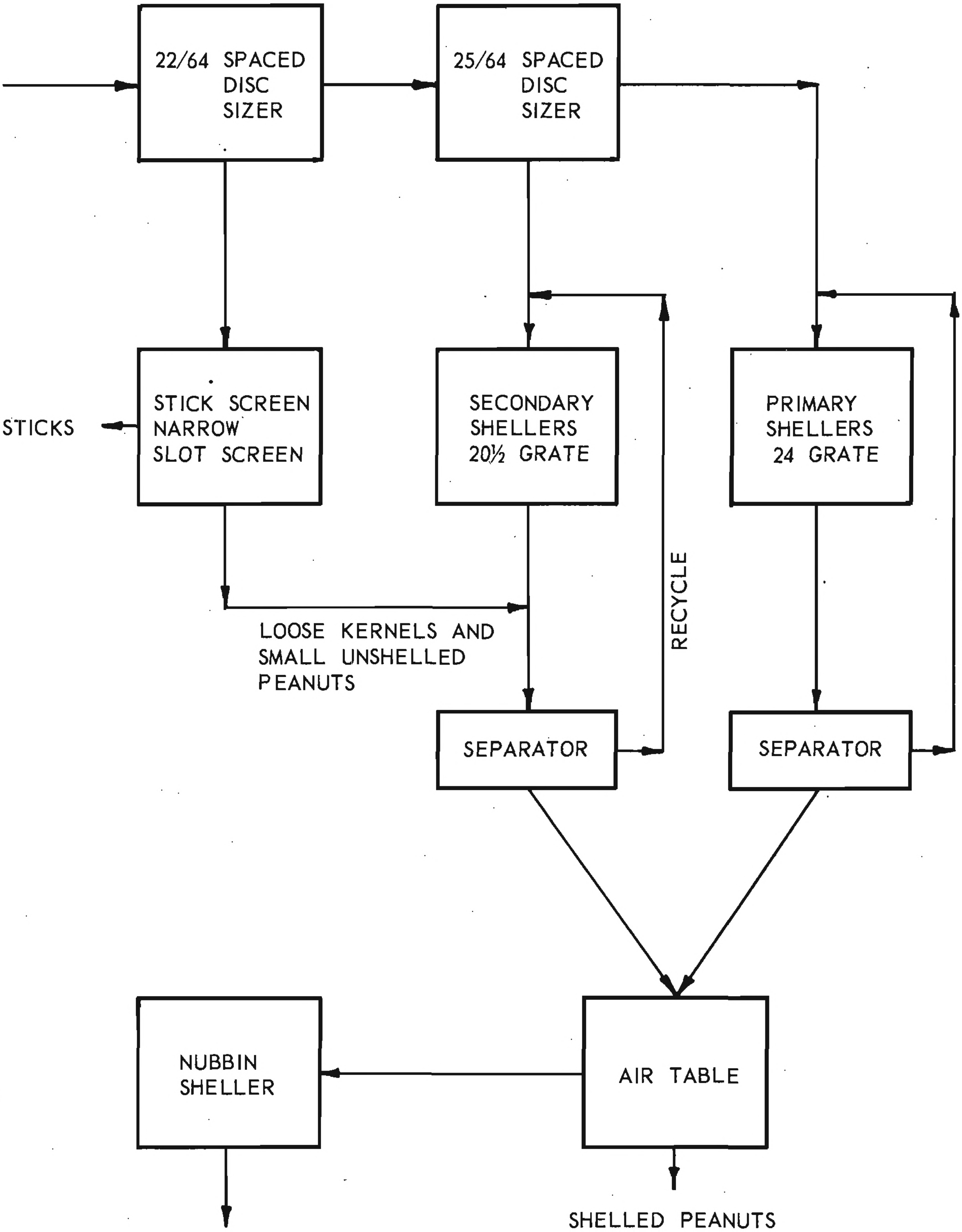

Figure 16. Hypothetical Flow Sheet of Peanut Shelling Operation in which Peanuts Are Sized Before Shelling.

Use of the rotary disc screen to size peanuts before shelling them promises the following advantages:

1. A 24/64-inch or larger grate may be used in the primary shellers, with consequent reduction in the percentage of split kernels and with maintenance of a high shelling percentage and shelling rate.

2. Loose kernels, small unshelled peanuts, and a large percentage of small sticks and trash from the major portion are concentrated in a small portion which can then be screened to remove sticks and loose kernels before the unshelled goods are sent to the shellers.

3. Sizing before shelling is a possible means of distributing the shelling load among available shellers more evenly than can be done with unsized peanuts.

4. Sizing before shelling suggests the possibility of recycling unshelled peanuts through both the primary shellers and the secondary shellers. Investigation of this possibility was not carried out, since it would necessitate continuous operation of the shellers until a state of equilibrium was reached with the recycle stream. This, however, was not feasible with the experimental equipment available.

D. Recommendations

Further laboratory-scale tests of sizing of farmers' stock peanuts before their shelling should be made. The factors of moisture and sheller speed should be closely investigated, with emphasis placed on factors which can cause reduction of the percentage split kernels.

VII. FUTURE PROGRAM

Concurrently with the laboratory and in-plant work which has been done, an industrial engineering survey of the peanut shelling industry has been conducted. This report will be published in the fall.

The testing and evaluation of existing models will be continued.

A pilot installation of the suction-type picker in a shelling plant is planned.

A laboratory model of the automatic electronic quality picker will be made and tested.

If time and funds permit, a study of the sampling and grading process will be made in an attempt to achieve design and construction of a semi-automatic sampling and grading machine.

A pilot-model sizing machine should be built and installed in a shelling plant in order to study closely the effect of sizing before shelling and the effect of recycling unshelled peanuts through the primary, as well as the secondary, sheller.

Respectfully submitted:

Thomas A. Elliott,
Project Director

Ben W. Carmichael,
Research Engineer

Approved:

Gerald A. Rosselot, Director
State Engineering Experiment Station

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION

Machinery For Grading Farmers' Stock Peanuts

T. A. Elliott and B. W. Carmichael

ENGINEERING EXPERIMENT STATION
COOPERATING WITH
GEORGIA EXPERIMENT STATION

Atlanta, Georgia

June 30, 1955

ENGINEERING EXPERIMENT STATION
of the Georgia Institute of Technology
Atlanta, Georgia

ANNUAL PROGRESS REPORT

PROJECT NO. 147

EFFICIENT PICKING, TRANSPORTING, HANDLING, STORING, AND SHELLING OF FARMERS' STOCK PEANUTS

Prepared for

ENGINEERING EXPERIMENT STATION
and
GEORGIA EXPERIMENT STATION

By

T. A. ELLIOTT and B. W. CARMICHAEL

June 30, 1955

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I. FOREWORD

The contents of this report describe the construction and the machinery of a pilot plant, located at Bainbridge, Georgia, and the semiautomatic grading equipment for handling 2-pound samples. This plant and equipment was used in experiments directed toward improving methods of receiving farmers' stock peanuts. Receiving includes weighing, sampling, grading, cleaning and depositing peanuts into storage bins. Results of the experiments conducted in the pilot-plant facility will be reported in a subsequent publication.

The design and construction of the pilot plant, the design and fabrication of the semiautomatic grading equipment and the coordination of the various cooperating agencies required approximately two calendar years, and this report covers progress for the periods June '51 to June '53.

Formulating the concept of this work and its planning and execution has been a joint cooperative project between the Georgia Experiment Station of the University of Georgia and the Engineering Experiment Station of the Georgia Institute of Technology.

Financial support for the work was provided by grants of Title II funds matched by funds from the Engineering Experiment Station. The Federal-State Inspection Service contributed the services of its personnel to perform the necessary inspection. The GFA Peanut Association provided the warehouse and all necessary personnel to handle the buying, movement, cleaning and storage of the peanuts. Funds for the pilot building were furnished by GFA, and the cost of the machinery was covered by the Commodity Credit Corporation.

II. ACKNOWLEDGMENTS

This project was made possible by the active work and support of Mr. D. H. Hardin and the board of directors of the GFA Peanut Association; Mr. John Dean, Assistant Administrator of the CCC; and Mr. H. M. Riley, of the Federal-State Inspection Service.

The construction of the facility and the subsequent operation and data collection involved the cooperation of the following agencies: The GFA Peanut Association, the Commodity Credit Corporation, the Federal-State Inspection Service, the Georgia Peanut Company, the Georgia Experiment Station and the Engineering Experiment Station.

The authors acknowledge with grateful appreciation the efforts of the following individuals and their organizations in aiding this research program: the GFA Peanut Association, the Directors, Delton H. Harden, Mgr., Joe Morgan, Gerald Palmer, Clarence Bates, C. W. White and Joe Malone (deceased); the Commodity Credit Corporation and Production Marketing Administration, S. R. Smith, Director, PMA, USDA, M. W. Baker, Department Director, Fruit and Vegetable Branch, USDA, C. B. Gilliland, Chief, Research Division, Fats and Oils Branch, PMA, USDA, M. E. Smith, Fruit and Vegetable Branch PMA, USDA and George Prichard, Director Fats and Oils Branch USDA; the Federal-State Inspection Service, Herbert M. Riley, William R. Cleveland, J. A. Curry, Art Sowell, Ralph Paulk, Cleveland Hobby and Claude Raines; Georgia Experiment Station, W. T. Fullilove, N. M. Penny, J. R. Russell, Charles Elrod, Gordon Futral and James Butler; and Engineering Experiment Station, J. J. Moder, Earle Denenberg and Earl R. Hay, Sr.

III. SUMMARY

This report describes a facility and equipment costing $19,618.00, built to enable comparisons of: (1) automatic versus tries sampling of farmers' stock peanuts, (2) 1,000-gram samples versus 100-gram samples and (3) grades of samples prior to precleaning, after precleaning and after eight months' storage.

The building to house the equipment contained a dump pit and three 5-ton holding bins. The machinery used in the tests consisted of two elevators, an electric hoist, two automatic sampling devices, an air-blast cleaner and a stoner. For grading the 1,000-gram samples, the following semiautomatic devices were used: (1) foreign material screen, (2) farmers' stock sample sheller and (3) splitter and inspection belt.

Automatic samples (1,000 grams) and conventional trier samples (100 grams) were taken before and after precleaning, and after eight months' storage, just before the peanuts were moved to the shelling plant. After shelling, a conventional sample was taken from the bagged peanuts.

The equipment was found to be capable of sampling and cleaning farmers' stock peanuts at the rate of 10 to 12 tons per hour. Residual foreign material after cleaning was less than 1 per cent. The automatic sampling device and the air-blast cleaner worked well throughout the test.

The semiautomatic grading equipment gave reproducible results, processed samples in a reasonable time period and functioned well mechanically throughout the test. However, more design and development on the semiautomatic grading equipment is deemed advisable.

Tabulation and analysis of data obtained will be presented in a subsequent publication.

IV. INTRODUCTION

During the past decade the price of farmers' stock peanuts has steadily increased. Concurrently, the systems of pricing peanuts have changed and at the present time the price is very precisely based on the 1 per cent difference in grade factors. This may be desirable from the marketing viewpoint. However, to assure equity to the buyer and the seller of peanuts, sampling and grading methods are needed which will be as accurate and precise as the pricing schedule. The consensus is that the present system of sampling and grading is not specifically as precise as the existing pricing system.

What then should be done? Should the existing pricing system be reduced to the level of the sampling and grading methods or should better methods of sampling and grading be devised?

On the premise that progress is made by improving existing methods, relaxing the pricing schedule would amount to a regression; consequently, work toward improving the sampling and grading methods seems the right approach. Thus, by combining the findings of previous work with new concepts, a new outline of the needed improvements and definition of the problem has been formulated.

A. Problem

Due to foreign material, nonrepresentative sample and smallness of the sample, the present sampling and grading procedures do not produce a grade that is as accurate as the pricing system.

The problem was to devise, test and evaluate new methods and facilities for receiving farmers' stock peanuts at country buying points with an over-all view of increasing the convenience, serviceability and efficiency of receiving. The receiving function includes weighing, sampling, grading, precleaning and placing in storage. The new system should be more efficient than those commonly in use. Efficiency as used here means doing the same job for lower inputs of resources or doing the job better for the same expenditures without sacrificing any of the services and conveniences.

The general problem broken into components shows the need for

1. A larger size sample
2. An automatic sampling device
3. Semiautomatic grading equipment
4. A high-capacity precleaning system

B. Objectives

1. Design and construct

   a. An automatic sampling device

   b. Semiautomatic grading equipment

      (1) Sheller
      (2) Sizing screens
      (3) Split separator
      (4) Splitter
      (5) Foreign-material cleaner

   c. A high-capacity precleaner

   d. A larger sample [In this case a 2000-gram sample (approximately 2 pounds) was used.]

2. Test the above-mentioned equipment considering operations, manpower requirements and power requirements.

3. Record costs of installation.

4. Evaluate the procedure in terms of adaptability to the peanut industry.

5. Compile data on the use of the experimental and conventional methods of sampling and grading.

C. Method

Special equipment was required to conduct the experiment. A farmer's stock precleaner with a capacity of 10 to 15 tons per hour was needed. A means of taking automatic samples from each load had to be developed. It was necessary to design and to build machinery which could be used in grading and which would be capable of handling 2-pound samples in the same length of time used to grade a conventional sample. This machinery was built and installed at the GFA property adjacent to the Association's warehouse at Bainbridge, Georgia.

At the beginning of the 1953 harvest season, loads of farmers' stock peanuts were weighed and sampled (sample No. 1) in the conventional manner by the Federal-State inspectors. Farmers were paid on the basis of this grade. The load was unloaded into the dump pit at the cleaning installation, elevated and automatically sampled (sample No. 2), run through the cleaning machine and cleaned of foreign material, and emptied into another pit for the second elevating. The load was again automatically sampled (sample No. 3) and deposited into holding bins. Each load was removed from the holding bin and placed on a truck again. A conventional gig sample (sample No. 4) was taken from this truck load. The cleaned load was then placed in the warehouse in bins segregated by type and damage content.

In June 1954, the peanuts were removed from the warehouse in 2-ton lots, run through the automatic sampler (sample No. 5) and loaded onto large semi-trailers. Gig samples were taken when the trailer was loaded half-depth and again when the truck was fully loaded (sample No. 6). Each loaded truck was moved to the Georgia Peanut Company shelling plant at Moultrie, Georgia, where each segregation of peanuts was shelled and records were made of each segregation.

A sample (sample No. 7) of the shelled peanuts was obtained and graded for each segregation in the conventional manner of sampling and grading shelled peanuts.

V. CONSTRUCTION OF FACILITIES AND DESCRIPTION OF EQUIPMENT

A. Pilot Plant Installation

1. Building

Figure 1 shows a side view of the building and also the typical construction used and the machinery and bins before siding was applied. The building housed the cleaning machinery, automatic sampling devices and three temporary (5 tons each) storage bins. In the plan view, the building was 16 feet wide and 37 feet long. The portion covering the machinery was 20 feet high, the part covering the bins was 30 feet high. Two elevator housings extended above these heights.

2. Electric Truck Hoist

A typical bridge-electric hoist was used to unload trucks. The hoist consisted of a frame which supported the bridge, the motor and the cables. The bridge structure could be rolled to accommodate any length truck. The trucks were backed underneath the hoist so that the front wheels rested in the cradle and the rear wheels were against the concrete stop at the edge of the pit. The hoist raised the front wheels until peanuts slid by gravity into the pit. One man was able to handle truck unloading.

3. Unloading Pit

The pit was of the self-emptying type, and the peanuts flowed to the base of the pit and into the entrance elevator. A manual control gate governed the flow from the pit to the elevator and, thereby, controlled the rate at which peanuts were processed. The pit was 10 feet long, 7 feet wide and 7 feet deep. The side adjacent to the elevator was vertical and the other sides and bottom sloped to the elevator entrance.

Figure 1. Pilot Plant and Machinery.

4. Entrance Elevator

The entrance elevator, with a rated capacity of 15 tons per hour of farmers' stock, lifted the peanuts 30 feet and then discharged them. The boot of the elevator was set 8 feet below floor level and the top extended above the 20-foot ceiling. This elevator was powered by a 2-horsepower motor.

5. Automatic Sampling Device

The discharged peanuts from the elevator passed through the automatic sampling device shown in Figure 2. The elevator, the sample-taking mechanism, the sample chute and the chute to the feed hopper are shown in this figure, which was taken from below. As the peanuts passed through the automatic sampling device, a flapper-type deflector was activated three times a minute for a time interval of 0.1 second. During this time the entire stream of peanuts was routed into the sample pipe. A 30-pound solenoid moved the flapper and was activated by a timing device shown in Figure 3.

During the 0.1-second intervals when the sampler was open, approximately 1 per cent sample of the load was obtained. This was routed down the sample pipe to a conventional divider, which diverted one-half of the sample to the pit and the other half into a sample tray. This amounted to a 0.5 per cent sample or approximately 10 pounds to the ton. When the total load had passed through the sampler, the contents of the sample tray were reduced by dividers to approximately 2000 grams, and the sample was ready to be graded.

6. Feed Screen

The feed screen and surge hopper, shown in Figure 4, is mounted atop the angle iron frame which also supports the air-blast cleaner. The surge hopper fed and spread incoming peanuts evenly across the screen. The first portion of

Figure 2. Automatic Sampling Device.

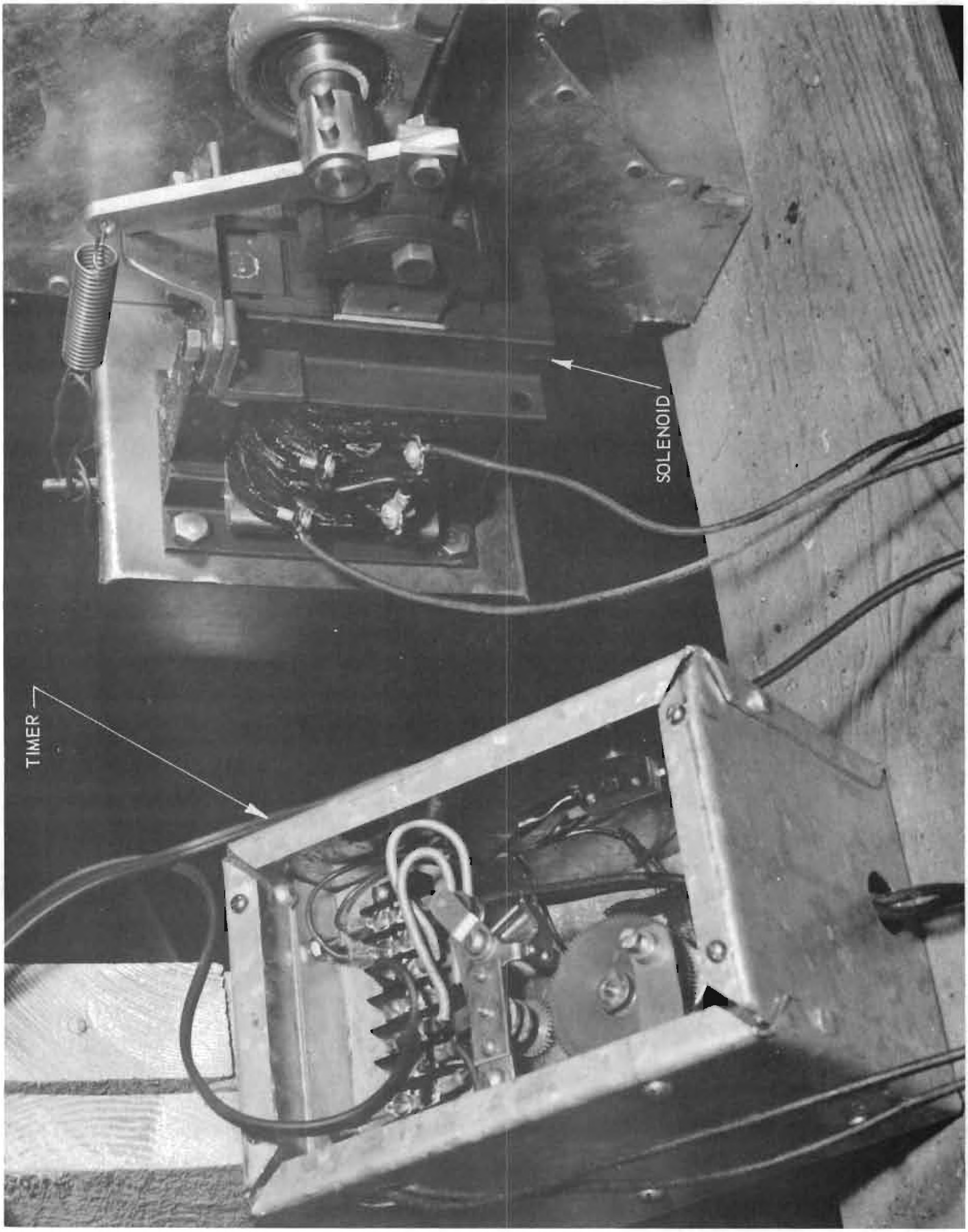

Figure 3. Timer and Solenoid.

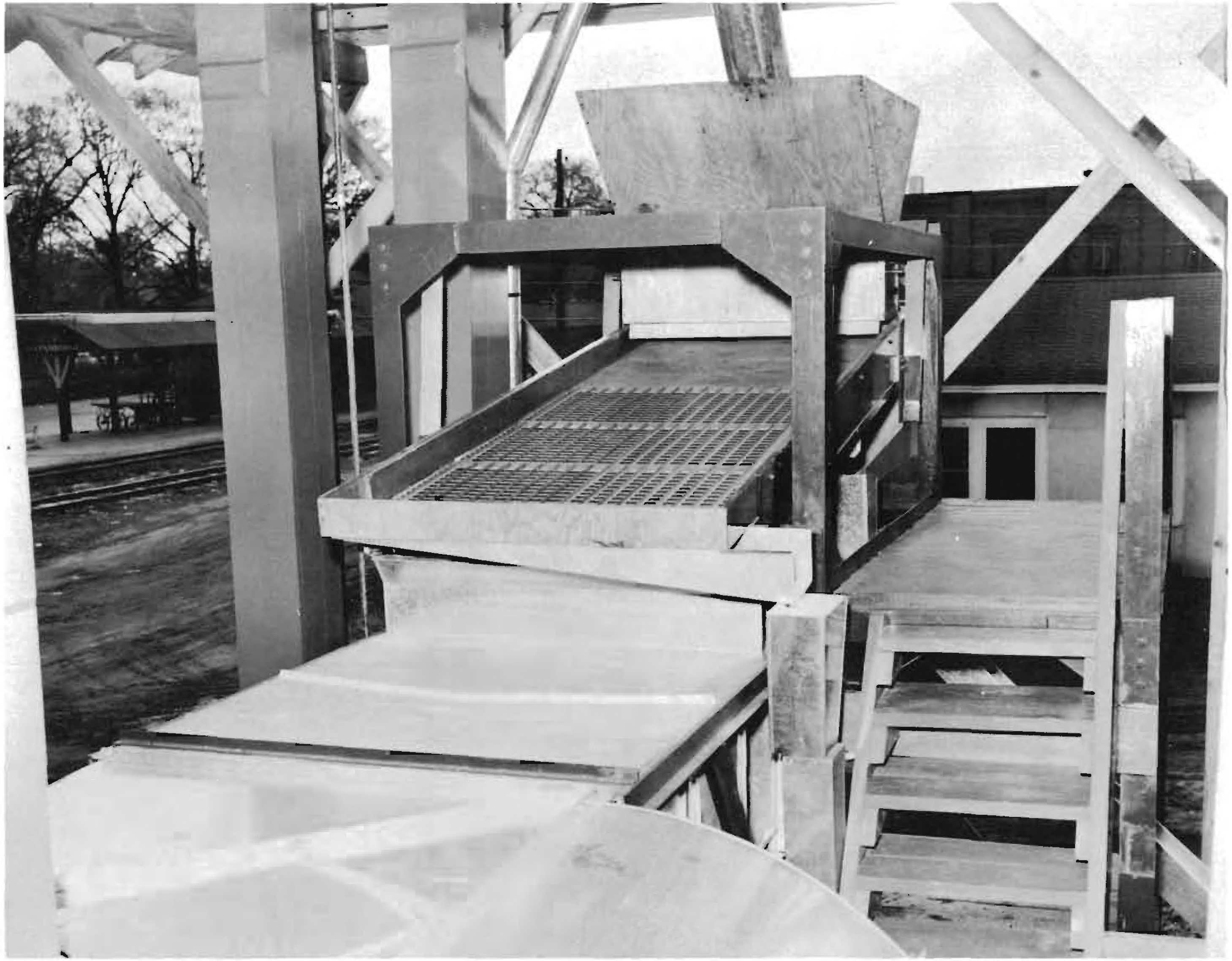

Figure 4. Feed Screen and Surge Hopper.

the screen has 1/8-inch round perforated holes for removal of dirt and sand exited to the outside by a metal chute. The second portion of the screen is a modified lip-type, on which large sticks and rocks rode and through which the peanuts fell. An Ajax-Shaler Shaker was used to drive the screen, which was suspended by hickory limberjims. The short fast strokes of the shaker moved the peanuts quickly down the screen in a steady stream and spread them evenly over the 4 foot width and fed them to the Air-Blast Cleaner. A 1750-rpm 2-horsepower motor was used to drive this unit. The feed screen as related to other components of the cleaner is shown in Figure 5.

7. Air Blast

The material from the feed screen fell into the air-blast stream which was 4 feet wide and 3 inches deep. A squirrel-cage blower discharging into a plenum, shown in Figure 5, delivered the volume of air required. A 5-horsepower motor was used to power the blower.

8. Division of Material Stream in the Air Blast

As the peanuts and other particles fell vertically through the horizontal air stream, they were displaced horizontally in relation to their weight and shape. The lighter particles and trash were blown through the duct and out of the building. The lighter peanuts and small sticks fell into the second partition and were routed to the slot screen. The heavy peanuts and stones fell into the first partition and were chuted to the stoner. The partitions were so located that 10 to 15 per cent of the load went over the slot screen and 85 to 90 per cent passed over the stones. The air-blast chamber and partitions are shown in Figure 5.

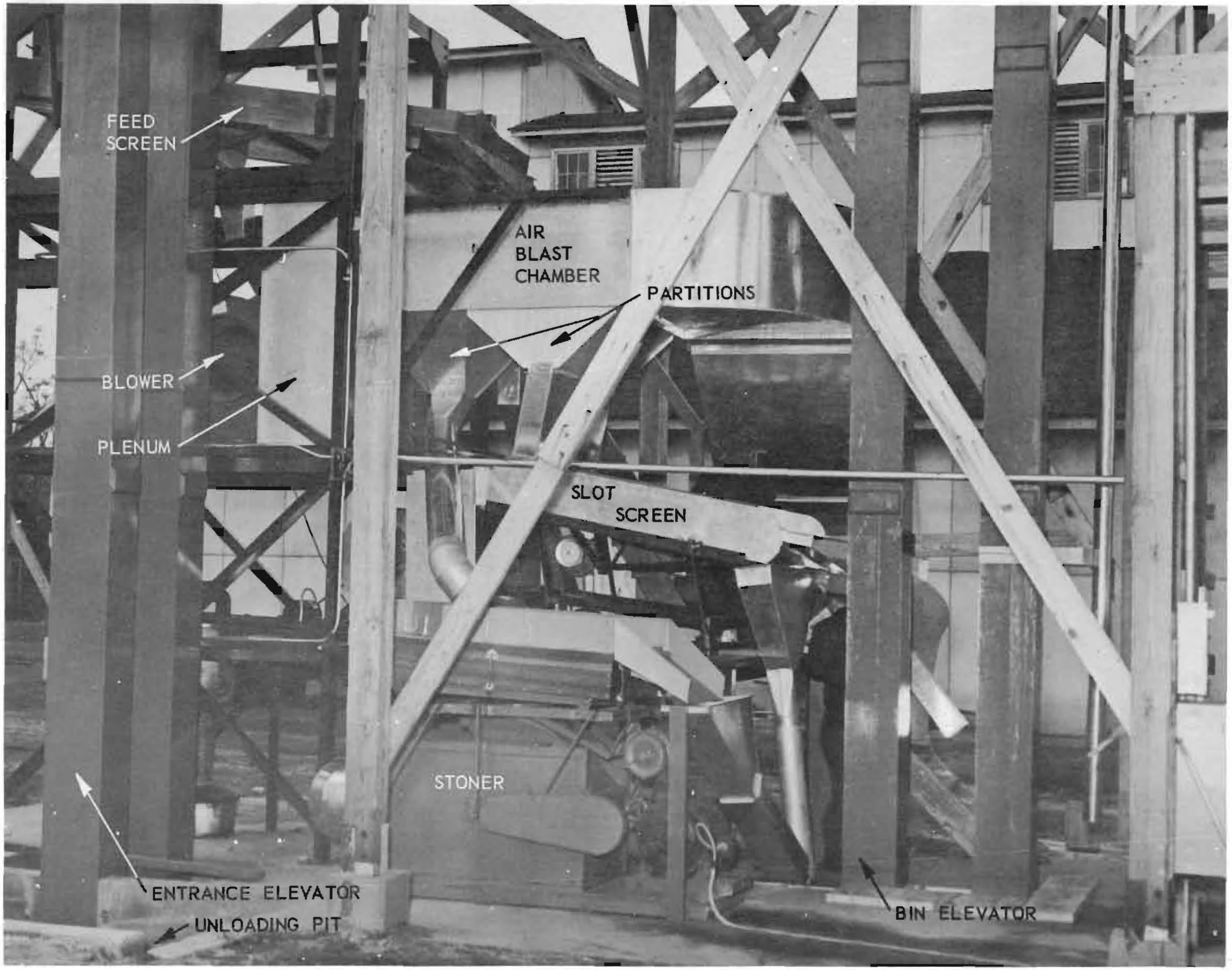

Figure 5. Complete Machinery Installation.

9. Slot Screen

The corrugated slot screen received the light peanuts and sticks from the air blast and separated the light peanuts from the "pops," hulls and sticks. The light peanuts were routed to the bin elevator boot and the sticks, hulls and "pops" were chuted out of the building.

This screen was driven by a No. 6 Shaler Shaker powered by a 3/4-horsepower motor. Air for this screen was supplied by a plenum chamber and a squirrel-cage blower powered by a 3/4-horsepower motor. This screen is shown in Figure 5.

10. Stoner

A Sutton Steele and Steele 40-60 Stoner was used to separate the rocks from the heavy portion of the peanuts. After separation, the peanuts were chuted to the boot of the bin elevator, and the rocks were fed to a wheelbarrow which was periodically emptied. This unit shown in Figure 5 was powered by a 15-horsepower motor.

11. Bin Elevator

The bin elevator with a rated capacity of 15 tons per hour lifted the cleaned peanuts 40 feet and discharged them through an automatic sampler. This sampler was identical to the one already described and was triggered by the same timing device. The sample also received the same treatment. The boot of this elevator was set 4 feet below floor level and extended 6 feet above the bins. A three-way valve permitted the peanuts to be placed in any of the three holding bins. This elevator, shown in Figure 5, was powered by a 3-horsepower motor.

12. Holding Bins

The three-self-emptying holding bins shown in Figure 1 were constructed of plywood and suitably reinforced. The level-full capacity of these bins was 5 tons each. Slide gates and chutes shown in Figure 6 were used to empty each bin as desired.

Figure 6. East Side of the Cleaner Building.

The long pipe shown in Figure 6 was used to load peanuts directly onto a truck when automatic sampling was required but cleaning not necessary or not intended.

13. Control Panel

The wiring of the installation was arranged in such a manner that all machine switches were located on one control panel shown in Figure 7. The machinery could be stopped completely in case of emergency by a master switch. A central-control panel was used due to the compactness of the cleaner. Remote switches for the truck hoist and the entrance elevators were placed at the receiving pit in order that the two devices could be controlled by the operator while watching the truck and unloading peanuts into the elevator.

14. Warehousing

Peanuts were carried from the cleaner to the warehouse in a dump truck having sides built up so that 2 tons of peanuts could be transported.

The peanuts segregated according to type and damage, as determined by sample No. 3, and stored in the warehouse.

Initially, the peanuts were placed in their respective locations by dumping from the truck. As the volume increased, bin partitions were placed and the peanuts were dumped and placed by belt elevator.

B. Semiautomatic Grading Equipment

1. Sample-Foreign-Material Machine

The machine shown in Figures 8 and 9 was designed to remove sand, rocks, sticks and light trash from a 2,000-gram sample of farmers' stock peanuts. Sand fell through a slot and out of a chute. Rocks were removed by means of an airlift, which permitted them to fall into the rock slot, and the remainder of

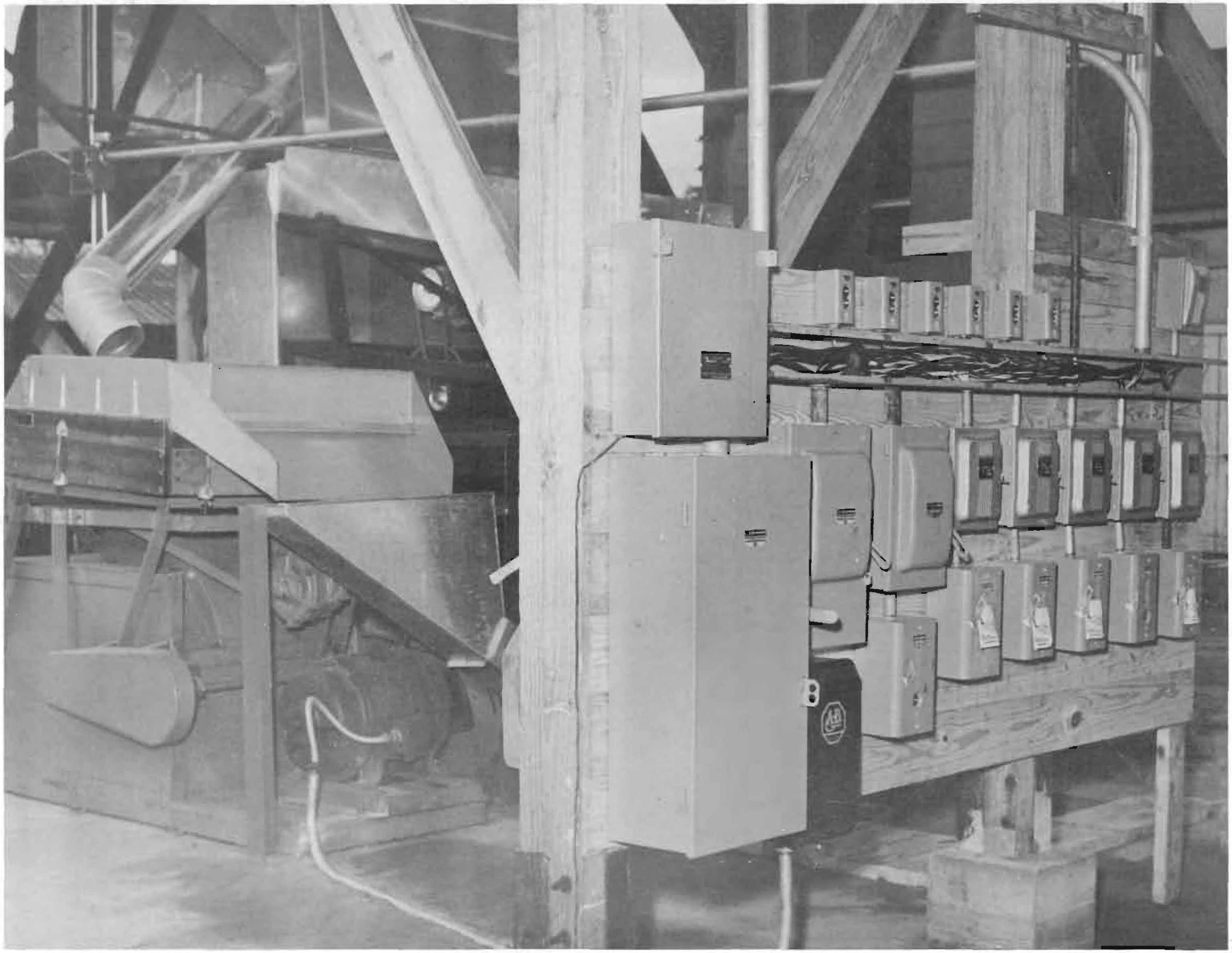

Figure 7. Control Panel.

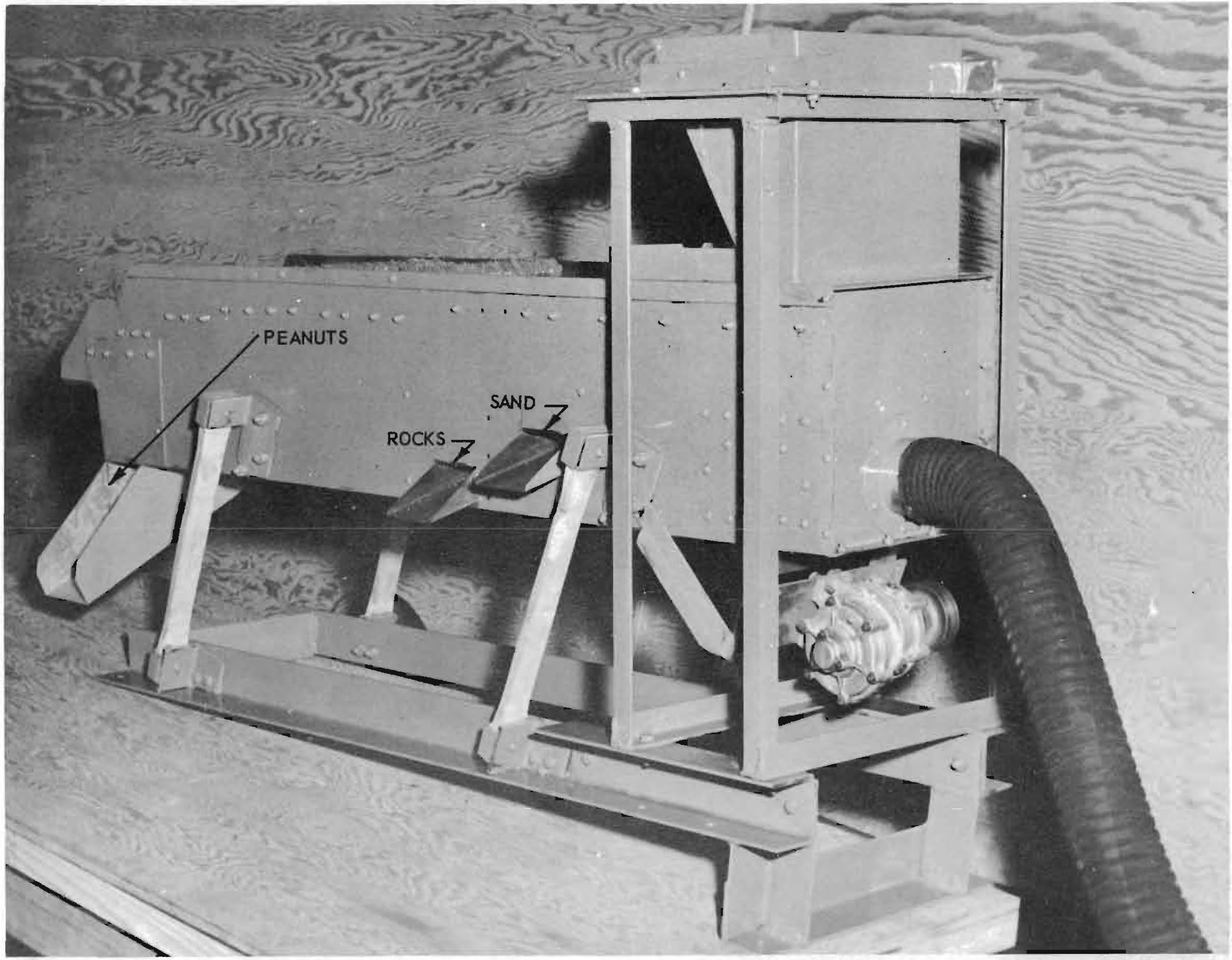

Figure 8. Side View of Sample-Foreign-Material Machine.

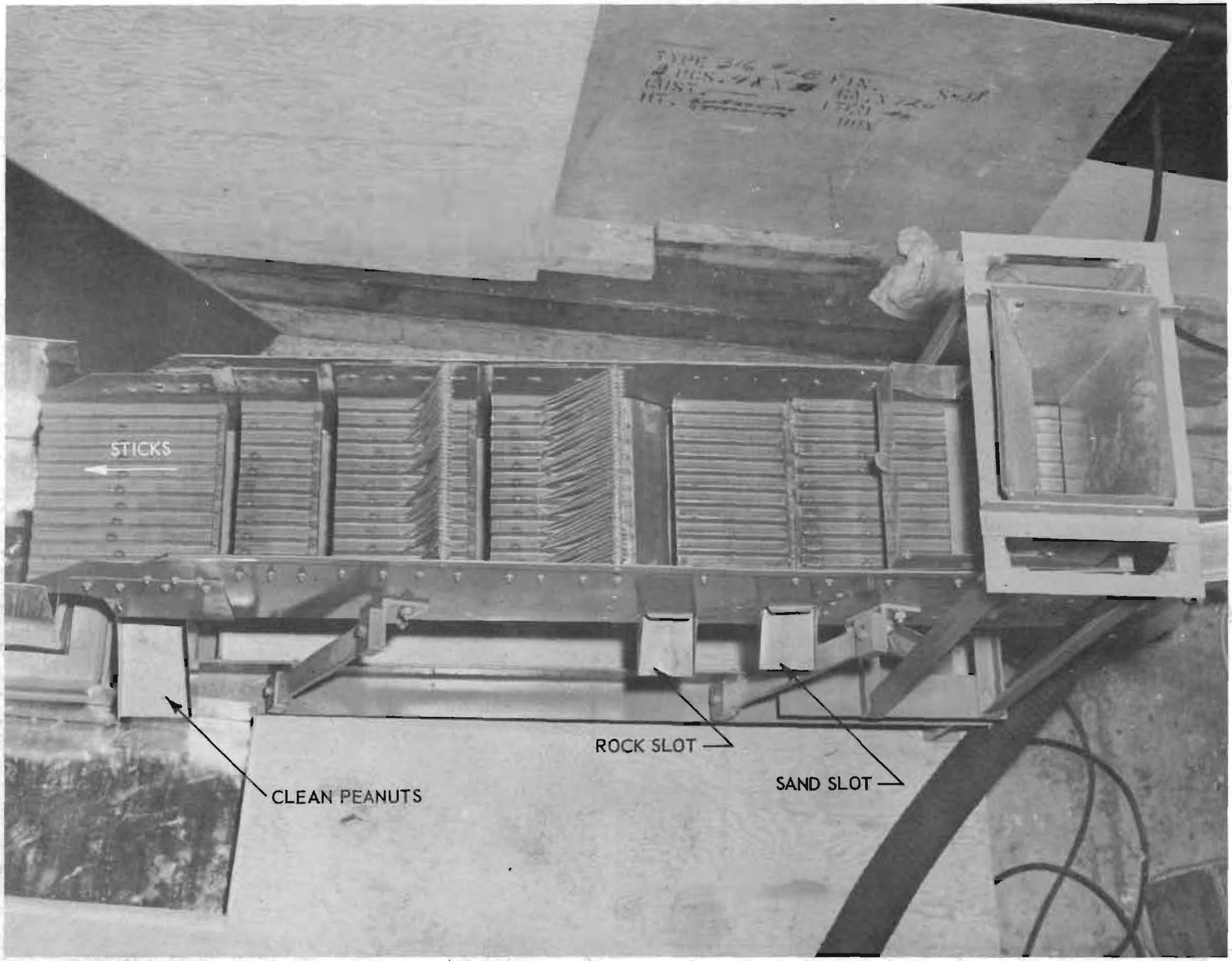

Figure 9. Top View of the Sample-Foreign-Material Machine.

of the material was blown over the end of the slot screen by means of an air blast coming through the slots. The clean peanuts fell through the chute into a tray after which they were visually reinspected and any remaining foreign material was removed. The loose-shelled kernels were removed by screening with a 3/8-inch-round-hole hand screen.

2. Scales

Direct reading scales were used to weigh the 2,000-gram sample for foreign-material determination and the 1,000-gram sample of clean, foreign-material-free peanuts. Use of a 1,000-gram sample permitted easy determination of percentages by merely weighing components and adjusting the decimal place.

3. Mechanical Sheller

The 1,000-gram sample of cleaned peanuts was weighed and placed into the mechanical-sheller hopper shown in Figures 10 and 11. The sample was fed at a uniform rate by a vibratory feeder into the sheller between two sandpaper belts moving in the direction of travel of the peanuts. The upper belt traveled at double the speed of the lower belt, and this differential speed caused the shelling action. The peanuts slid down a chute from the sheller by a suction pickup which removed the loose shells and carried them to a cyclone separator. A conveyor belt carried the peanuts to a rotating cylindrical screen, by which kernels were removed, and the unshelled peanuts were returned to the hopper of the vibratory feeder, thus completing the cycle. The kernels were fed over a grade screen which removed the splits and shrivels. The splits were separated from the shrivels by an inclined belt. The peanuts were circulated continuously until shelling was complete. To accomplish the shelling task, the space between the belts was slowly decreased so that the larger peanuts were shelled and then the smaller ones. Any unshelled peanuts passing through the cylindrical screen were picked up by hand and recycled.

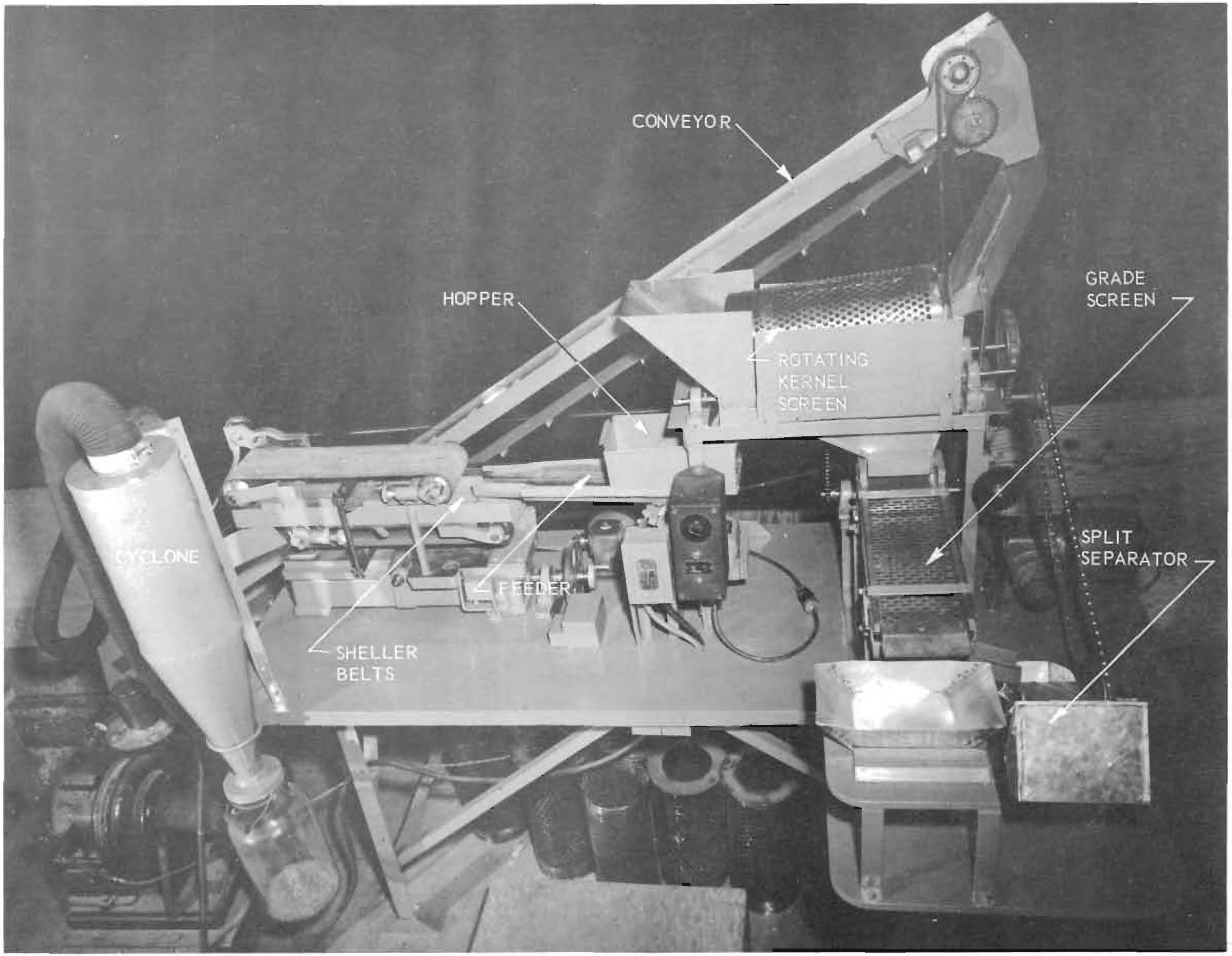

Figure 10. Top View of Mechanical Sheller.

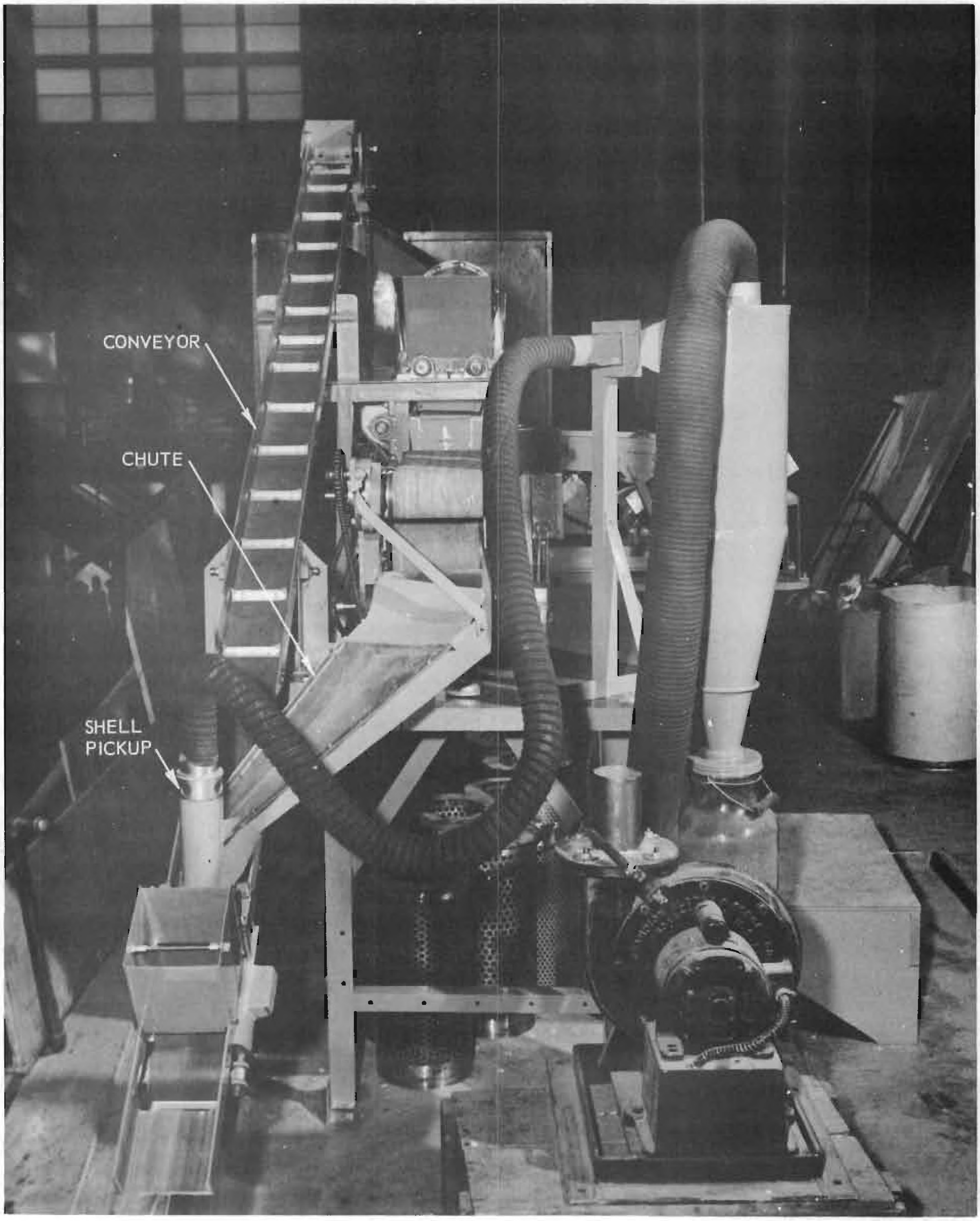

Figure 11. End View of Mechanical Sheller.

This machine shelled the peanuts, removed the various components and separated the large kernels, shrivels and splits. Each portion was then weighed and recorded. The sample shelling machine was designed for the purpose of shelling a 1,000-gram sample with as low percentage of splits as possible and recovering the components of the sample in order that they might be weighed. The time for shelling a 1,000-gram sample was approximately 8 minutes.

a. Shelling Belts. The spacing between the shelling belts could be varied between a maximum of 44/64 inch and a minimum of 20/64 inch causing a space decrease of 3/8 inch during the shelling cycle. This spacing was satisfactory for shelling of either Spanish or Runner peanuts. A magnetic kickout clutch stopped the machine when the belts were at the minimum spacing and sounded a warning bell.

b. Shell Removal. The suction pickup, shown in Figures 10 and 11, using an air velocity of 1,000 feet per minute was used to remove the shells from the shelled and unshelled peanuts. This air velocity was used as it did not pick up small kernels. A catch pan was located under the shelling belts for receiving bits of shell and dust. When shelling was completed, the shrivels and splits were circulated separately past the suction to remove any bits of shell, husk and dust.

c. Cylindrical Screen. The rotating cylindrical screen shown in Figure 10 separated the kernels from the unshelled peanuts. A 27/64-inch-round-hole screen was used for Runners and 24/64-inch-round-hole screen for Spanish.

d. Grade Screen. Kernels from the cylindrical screen were routed over the flat grade screen shown in Figure 10. Large, mature kernels rode the screen and splits and shrivels fell through. This screen was vibrated by an eccentric. The screen proper could be changed easily by raising the frame as shown in Figure 12, and the screen for a particular variety could be inserted. A 14/64 x 3/4-inch slot was used for Spanish and 15/64 x 3/4-inch slot was used for Runners.

e. Split and Shrivel Separation. An inclined belt, shown in Figure 10, was used to separate splits and shrivels. Upward movement of the belt caused the splits and the shrivels to rotate until the flat face of the split rested on the rough belt, after which the split rode up the belt and was effectively separated from the splits. This operation was necessary to allow for the kernels split by the shelling operation.

4. Kernel Splitter and Inspection Belt

To facilitate hidden-damage inspection, a device was constructed to split the whole kernels automatically and pass them split side up by an inspector. This was accomplished by utilizing a combination of several elements: (1) a feed mechanism, (2) a splitter, (3) an inclined belt and (4) a wraparound belt. A schematic diagram, Figure 13, illustrates the location of these components in this machine. The feeder mechanism consisted of two grooved rolls, which kept the kernels agitated in the hopper so that they would feed single file through the groove. The kernels passed through the feeder and dropped between a rubber-covered roller and a curved plate which split the kernels and dropped them on an inclined belt. The angle of the belt was such that the splits would roll until the flat face was down on the sandpaper belt. In this position the kernel would ride up the belt. At the top, a wraparound belt retained the kernel in its same relationship with the sandpaper as it moved around the pulley and to the underside. As the split kernels and the wraparound belt emerged from

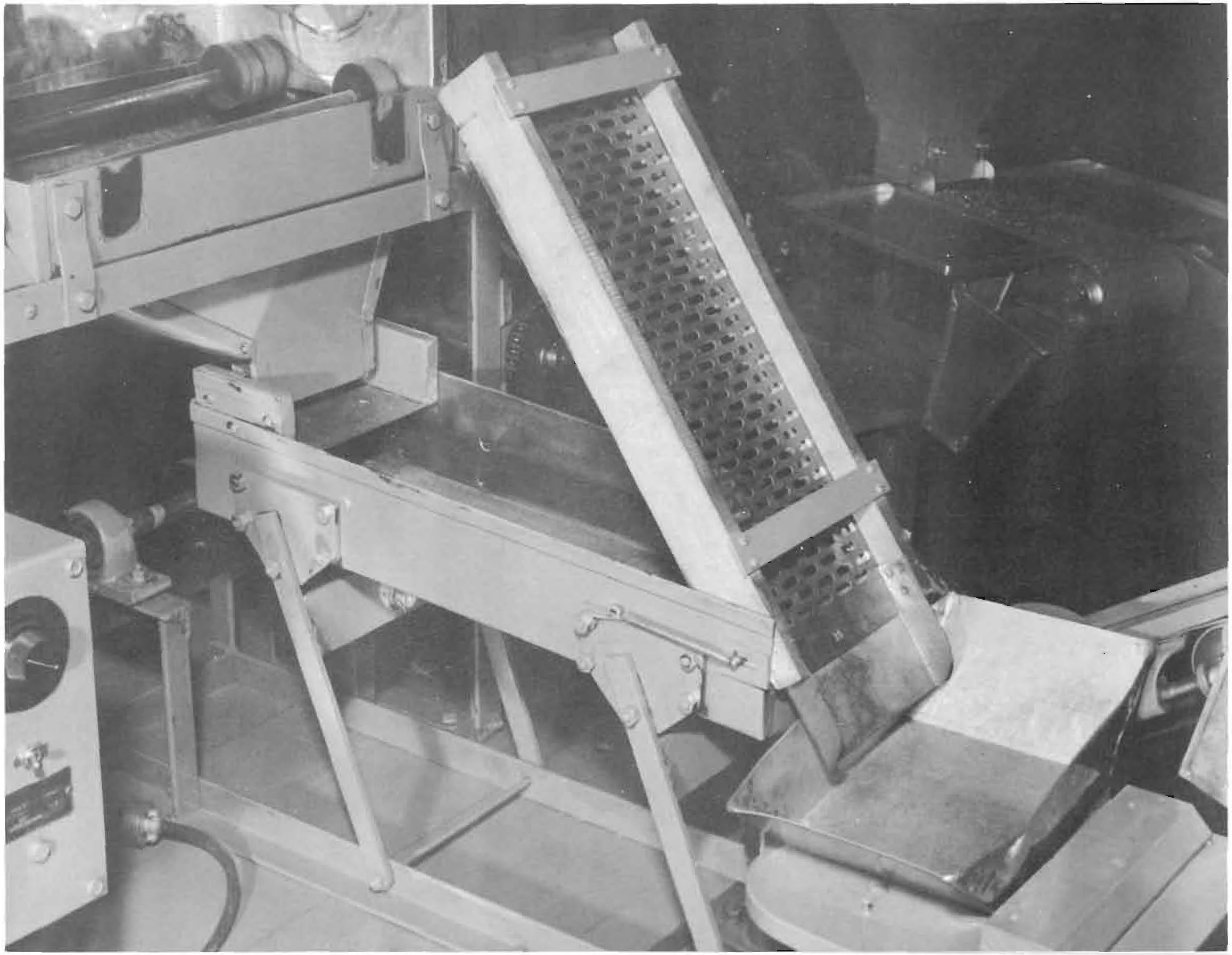

Figure 12. Grade Screen Raised for Quick Change.

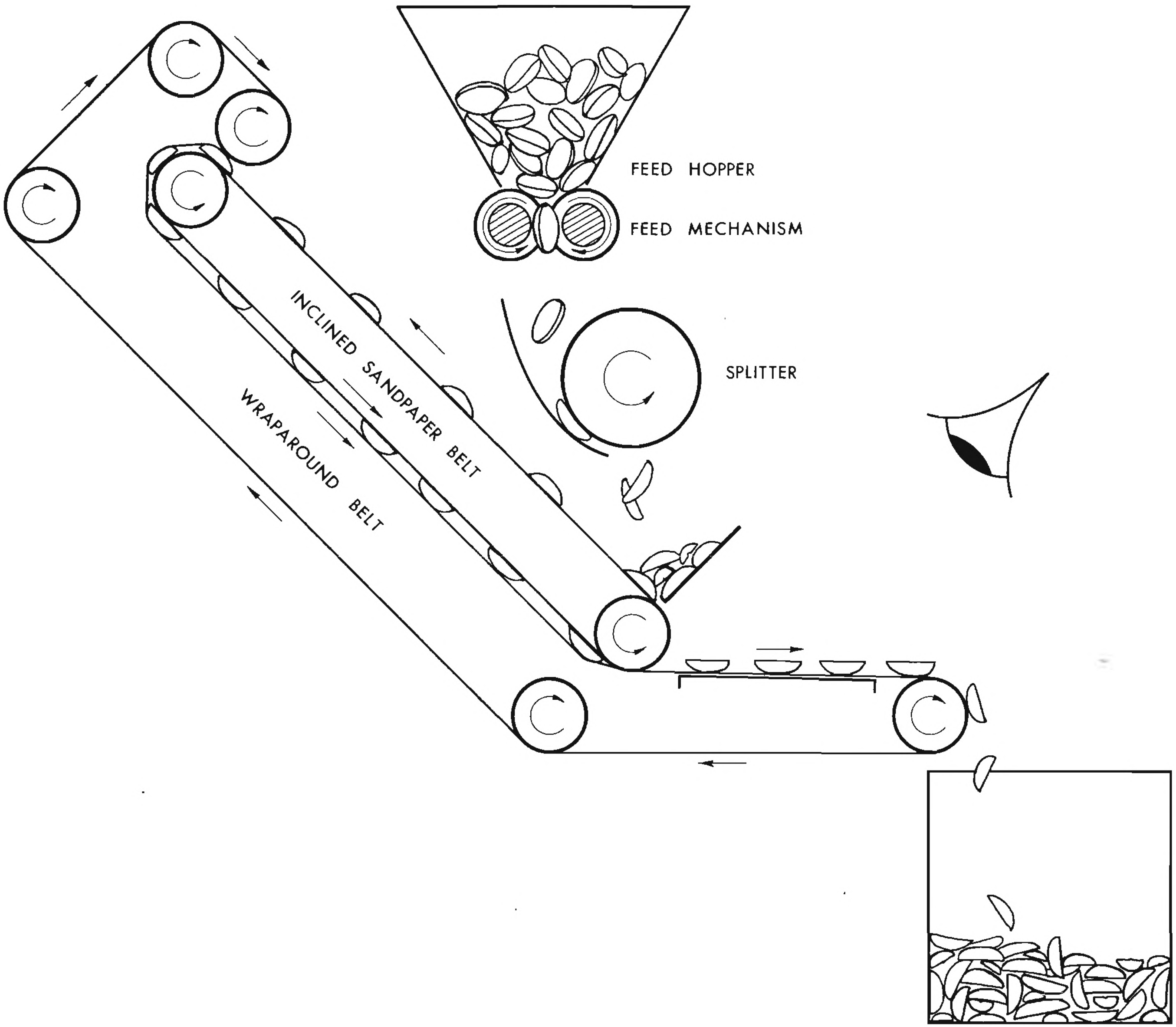

Figure 13. Schematic Diagram of Peanut Splitter and Picking Belt.

under the bottom pulley, the split face of the kernel was up. The wraparound belt then moved horizontally so that an inspector could inspect for and remove concealed damaged kernels. A foot switch controlled movement of the belts, which could be stopped for closer inspection. Normal belt speed was 10 feet per minute. A 1/20 horsepower ratio motor was used to drive this unit.

5. Sampling and Grading Procedures

Samples were numbered consecutively in the order in which they were taken from the load. Samples 1, 4 and 6 were obtained by a trier. Samples 2, 3 and 5 were taken by automatic sampling. Sample 7 was taken from bags as loaded into freight cars.

All trier samples were reduced to 500 grams for foreign-material determination and 100 grams for the balance of the grading. All automatic samples were reduced to 2,000 grams for foreign material and 1,000 grams for grading. Samples from bags were 10,000 grams for Spanish and 15,000 grams for Runners for each segregation.

The following determinations were made on all samples:

1. Percentage of foreign material
    a. Rocks and dirt
    b. Sticks, hay and hulls
2. Percentage of loose-shelled kernels
3. Percentage of damage content
    a. Discoloration
    b. Visible
    c. Concealed
4. Percentage of sound mature kernels
5. Percentage of other kernels less splits
6. Percentage of splits
7. Percentage of hulls
8. Percentage of moisture

VI. COST OF EQUIPMENT

Building		
Slab, building, bins and pit	$3,740.00	
Dog houses and siding	1,400.00	
Wiring, starters and labor	833.50	
		$5,973.50
Electric Truck Hoist		
Bridge and drive	726.00	
Frame and erection	125.00	
		$851.00
Elevators		
Entrance with drive	1,238.59	
Bin with drive	1,450.29	
		$2,688.88
Feed Screen		
Feed screen and stand	1,133.00	
Shaler shaker	235.00	
Motor and drive	110.00	
		$1,478.00
Air Blast		
Large and small plenums, chamber and feed chute and exhaust	419.20	
Blower motor and drive	450.00	
Slot screen and frame	205.00	
Shaker and motor	140.00	
Blower and motor	75.00	
		$1,289.20

Stoner		
Sutton Steele and Steele 40-60 Stoner	$1,650	
Motor base and starter	360	
		$2,010.00
Automatic Samplers and Semiautomatic Grading Equipment		1,868.02
Miscellaneous Hardware and Welding		212.45
Warehouse Bin Material		1,012.45
Truck Rental		200.00
Installation Supervision and Labor		1,759.57
Freight and Express		176.31
	TOTAL*	$19,619.38

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*Additional truck rental and operational repair and maintenance are not included in total.

VII. EVALUATION OF MACHINERY AND FACILITIES

A. Building and Machinery

1. Building

For the purpose of this test the building was adequate. The original plans did not include siding, however, due to the duration of the test and no full-time personnel present, the enclosing of the building prevented pilferage and damage to the equipment. For constant use of industrial-type precleaners, an open building is recommended but one that will sufficiently protect machinery from various weather conditions.

2. Electric Truck Hoist

This low-cost hoist worked well and one man was able to handle unloading and operate the entrance elevator. The framework on which the hoist rested was not quite high enough. As a result, the long trucks could not be lifted high enough to empty completely by gravity.

No operational troubles were encountered in the use of the hoist. There was no objection by any of the farmers to this type of unloading.

3. Unloading Pit

This pit functioned well and gravity fed all of the load except the last few pounds. Because the pit was concrete and not smoothly finished, the last portion of each load tended to cling to the pit. A steel-lined pit or a hard-troweled concrete finish is recommended.

4. Elevators

The elevators operated well mechanically but did not deliver the rated 15 tons per hour of farmers' stock. Actual capacity was approximately 12 tons per hour, and the unit usually ran at this speed. Where extremely high-foreign-material loads (25 to 40 per cent) were encountered, flow was slower due to high concentration of stems.

5. Automatic Sampling Device

Both automatic sampling devices worked satisfactorily throughout the test. The downspout from the first sampler had to be enlarged from a 4 inch diameter to a 6 inch diameter as the smaller spout clogged when foreign-material content was high. A 4-inch downspout worked satisfactorily on the cleaned peanuts. No mechanical damage, splitting or shelling was noted in the peanuts falling down through the tubes.

6. Feed Screen

The mechanical action of this screen was good and it handled the volume well. The sand screen was long enough and did not remove all sand and dirt. Flat sand screens are prone to clog and are not recommended for farmers' stock precleaning. A rotary disc* type screen is the most efficient and should be used prior to all cleaning devices for (1) large stones, wood, etc., and (2) sand removal. Furthermore a screen of this type should be used after cleaning.

The louvre-type screen did a good job of separating large sticks, stems, cobs and rocks from the peanuts. Medium-sized rocks clogged it and had to be cleaned about once an hour. This type of screen is more satisfactory than flat screens.

7. Air Blast

No operational troubles were encountered with the air blast. The performance of this unit was excellent. The light and heavy peanuts were segregated to the slot screen and stoner. The light chaff, hay and leaves were blown to the outside of the building. Once this unit is set and adjusted no further care or supervision is required other than routine maintenance of blower and motor bearings. The unit seemed to handle the volume satisfactorily and the cleaning was

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*See "Rotary Disc Screens from old Gin Saws" by T. A. Elliott, July 1955.

excellent. Over-all data showed less than 1 per cent of the foreign material was left in the peanuts.

8. Slot Screen

The slot screen received 10 to 15 per cent of the total load which amounted to 1 to 1.5 tons per hour and in many cases the stem concentration in this portion amounted to 30 per cent. The stems were effectively removed and the screen did not clog or require cleaning by an operator. Air adjustment on this screen was required about once every 2 weeks; as the average moisture content of peanuts decreased, the air velocity was reduced. This adjustment was made easily and quickly by moving a slide gate valve.

9. Stoner

The stoner worked well throughout the test and removed most stones from the peanuts. One breakdown occurred because of a roof leak which ruined some plywood and caused the stoner to stop functioning properly.

10. Holding Bins

The bins served the purpose satisfactorily and were easily emptied. Some difficulty was encountered in placing the truck properly when unloading the bins. An alternate design is a bottom unloading bin centered over the truck to allow a more compact structure for the same volume of peanuts. Three-fourths of an inch of plywood is recommended for bin construction from a functional standpoint, also it requires less labor to install.

Bins did not clog and the free flow of peanuts enabled empting of bins in 2 to 5 minutes. The use of bins prior to precleaning is not recommended because of arching and clogging tendencies of high-foreign-material peanuts.

11. Control Panel

Electrical troubles were not encountered. Central control switches permitted gradual electrical line loading and quick shut-off of all machine elements in emergency situations.

B. Semiautomatic Grading Equipment

1. Sample-Foreign-Material Machine

The foreign material was efficiently and rapidly removed by this machine from a 2,000-gram sample. Very little hand picking was necessary and was mainly confined to removal of loose-shelled kernels from the rocks. The time for inspecting, grading and analyzing a sample was approximately 5 minutes.

2. Mechanical Sheller

This sheller operated without any major mechanical failure during the test. It required 8 minutes to process a 1,000-gram sample. The percentage of splits made in this sheller was very consistent and could be used as a standard to determine splits as a grade factor. On comparative samples the reproducibility of grade was uniform. The flat grade screen gave good reproducible results and was more consistent and reliable than a hand screen.

This machine was considered to be too large and expensive for industry adaptation. It served the experimental purpose and demonstrated the need for further research and development of a sample sheller.

3. Kernel Splitter and Inspection Belt

This new method of splitting peanuts was successful in most cases and is a considerable improvement over the hand and knife method. It permitted a 1,000-gram sample to be inspected in the same time now used to inspect a 100-gram sample.

Some difficulty was experienced in splitting peanuts with moisture content over 8 per cent as the kernels tended to mash rather than split into halves. Some further work is needed to overcome this trouble.

C. General

The operation of the precleaner required two workmen. By adaptation of a self-cleaning screen, one man could easily run this unit. Without exception all farmers who saw the unit favored automatic sampling as being the preferable method. Most of them said that if possible they would prefer precleaning prior to sampling.

Every warehouseman and visitor who saw the cleaned peanuts in storage was impressed by the clean appearance. When the peanuts were loaded out of storage in June, the warehouse crew did not find it necessary to wear handkerchiefs or dust masks to move the peanuts. In fact, the foreman of this group generally wore a white sport shirt which was not discolored by dust during the day. This contrasted extremely with the usual experience in removing dry peanuts from storage.

A relatively small tonnage of farmers' stock peanuts, 500 tons as compared to 5,000 tons for the medium-sized plant, was handled at this buying point. However, it points out the possibility of using a unit of this type at buying points in the future--where 10 to 12 tons per hour can be precleaned and automatically samples, 100 to 120 tons per day can be handled. Fees charged for cleaning peanuts with foreign-material content would almost retire the investment in a cleaning unit. An alternate possibility would be the adaptation of a hoist, pit, elevator or belt, and an automatic sampler at buying points. Results indicate that the accurate sample thus obtained would in time pay for the investment in this equipment.

The semiautomatic grading equipment was operated by the Inspection Service personnel and demonstrated that a larger sample could be processed in the same time required for a 100-gram sample.

The size and complexity of this machinery indicate additional work should be done. A smaller and faster sheller, a fast grade screen and a high moisture splitter would enable rapid analysis of large samples.

Respectfully submitted:

T. A. Elliott
Project Director

Ben W. Carmichael
Research Engineer

Approved:

Paul K. Calaway, Director
Engineering Experiment Station

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